

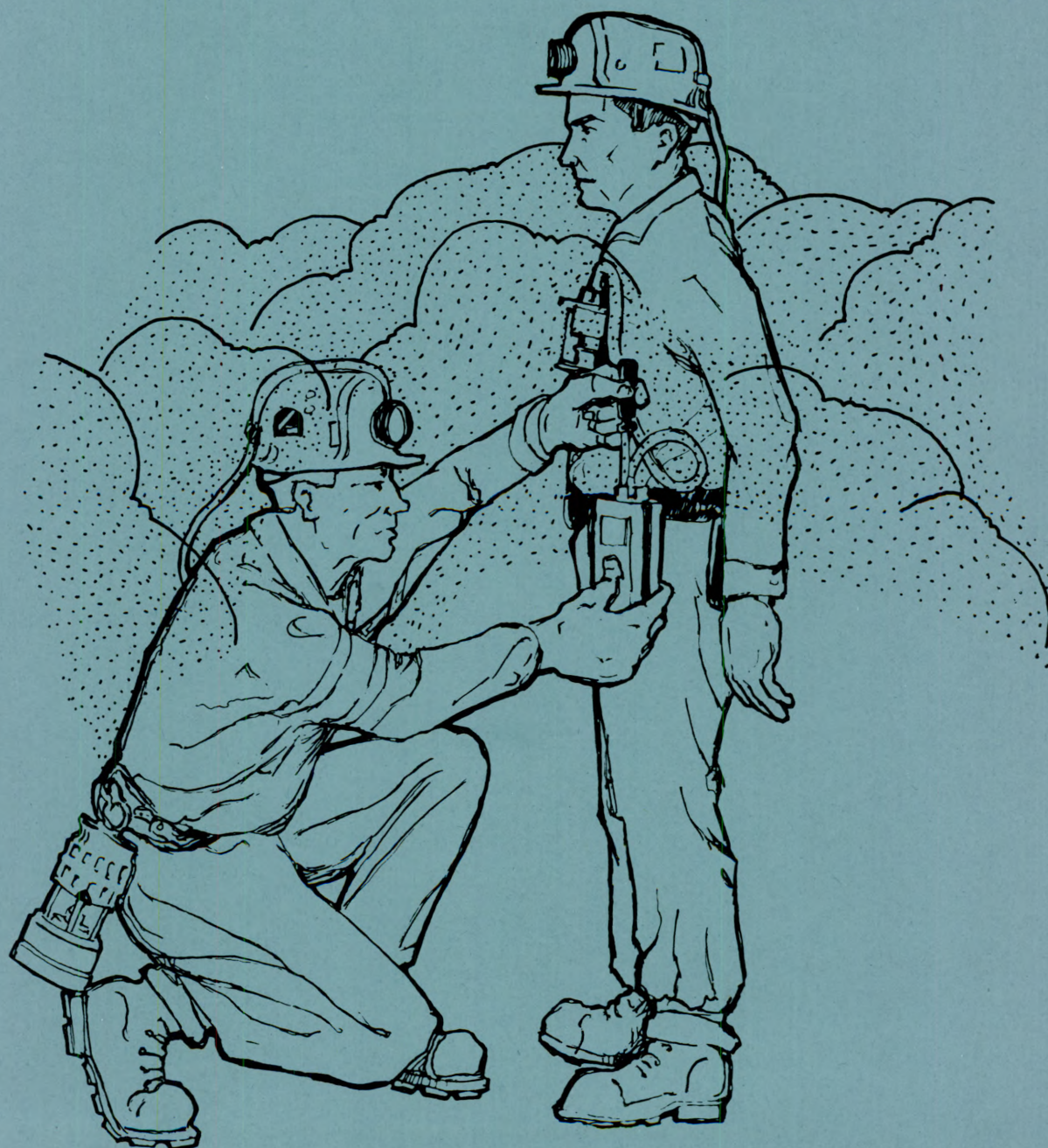
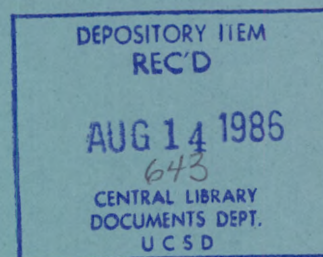
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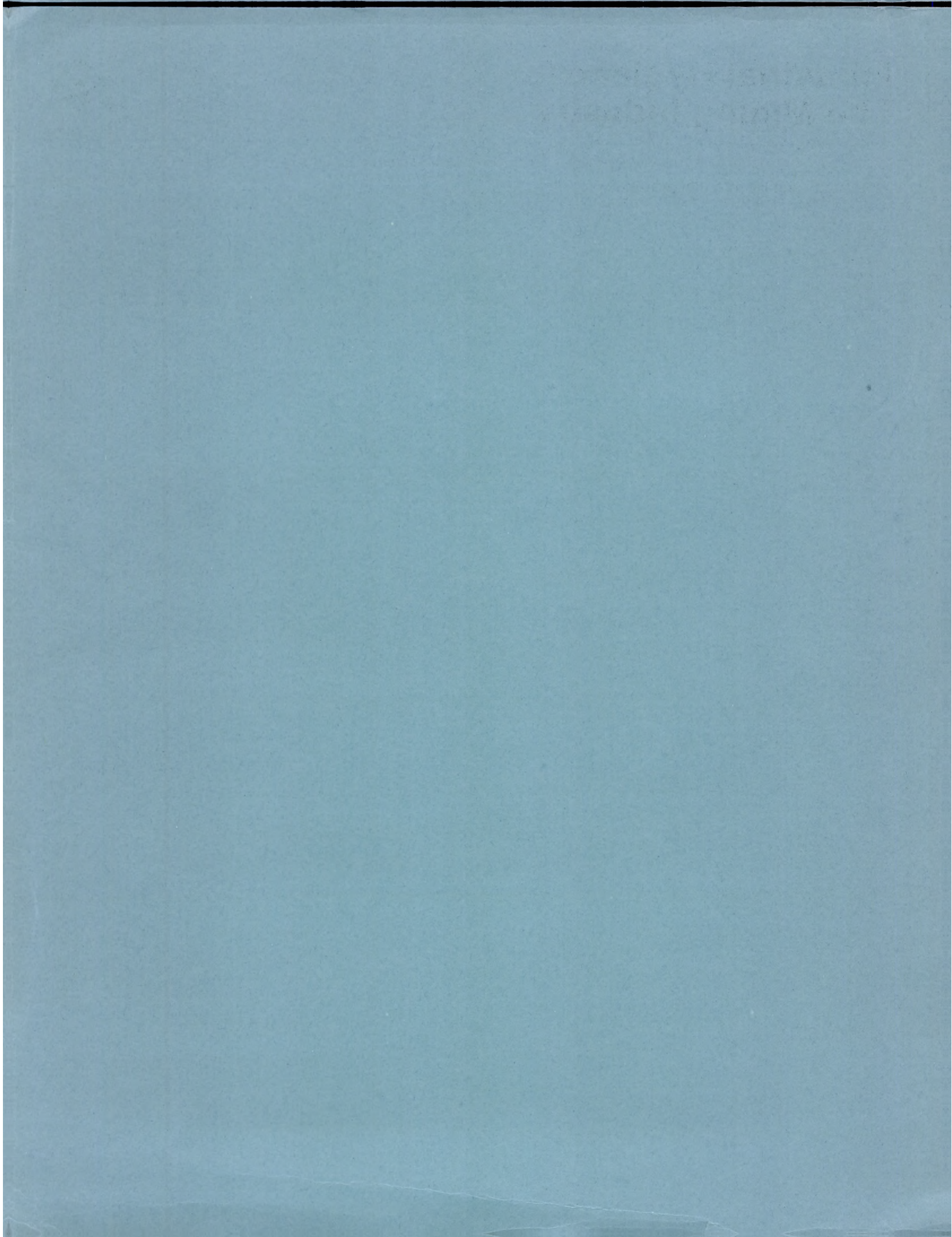
Industrial Hygiene for The Mining Industry



U.S. Department of Labor
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National Mine Health and Safety Academy

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Industrial Hygiene for The Mining Industry



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Programmed Instruction Workbook No. 12



PREFACE

This is one of a series of programmed instruction workbooks developed and published by the National Mine Health and Safety Academy. Twelve such workbooks have been developed in the subject areas listed at the back of the book. The format is designed for self-paced, individual study, and the information is primarily for the user who has no experience or training in the subject area. Those who have some experience and knowledge in the subject may cover the basic material at a rapid pace and find the book useful for review.

The accident frequency rate for the entry-level miner has, unfortunately, been notably higher than that for the experienced miner. One of the important objectives of this series of workbooks is to support and complement other training given to entry-level miners and, in this way, to contribute to their safety and health.

This publication is for instructional purposes only and is not intended to change or influence existing MSHA policies or directives. This particular volume was prepared initially by an independent contractor and was subsequently revised, edited, and printed by the U.S. Department of Labor. As it is a new publication in a new format, a limited initial printing has been made so that content and form can be perfected prior to general distribution. A questionnaire has been provided at the back of the book. Comments are invited from all users.

TABLE OF CONTENTS

	PAGE
PREFACE	i
INDUSTRIAL HYGIENE AND THE HUMAN BODY (SECTION A)	1
INTRODUCTION	3
THE RESPIRATORY SYSTEM	12
CARDIOVASCULAR SYSTEM	24
LIVER FUNCTION	32
KIDNEYS	33
CENTRAL NERVOUS SYSTEM	38
MUSCULO-SKELETAL SYSTEM	41
SKIN	47
THE EAR	51
THE EYE	56
RECOGNITION OF HEALTH HAZARDS (SECTION B)	67
TOXICOLOGY	69
ROUTES OF ENTRY	71
DOSE-RESPONSE RELATIONSHIP	74
CHEMICAL HAZARDS	81
SOLVENTS	81
INDUSTRIAL SKIN DISEASE	85
GASES	90
DUSTS	95
FUMES	101

	PAGE
MISTS	104
PHYSICAL HAZARDS	107
NOISE AND VIBRATION	108
TEMPERATURE AND PRESSURE	114
ILLUMINATION AND RADIATION	122
BIOLOGICAL/ERGONOMIC STRESS	129
EVALUATION AND CONTROL OF HEALTH HAZARDS (SECTION C)	137
EVALUATION AND MEASUREMENT	139
DIRECT-READING INSTRUMENTS	144
PREVENTION AND CONTROL	165
APPLICATION OF CONTROLS	184
INDUSTRIAL HYGIENE AND MINING (SECTION D)	195
ACCIDENTS	197
THE LAW	199
MINE HAZARDS	200
MINE ATMOSPHERE AND GASES	201
RADIATION	217
HEAT STRESS	221
DUST AND NOISE	223
SKIN DISEASE	232
ILLUMINATION AND ERGONOMICS	233
OTHER SAFEGUARDS	237
QUESTIONNAIRE	245

ILLUSTRATIONS

FIGURE		PAGE
	<u>SECTION A</u>	
1A	RESPIRATORY SYSTEM	13
2A	AIR SAC	17
3A	BREATHING CYCLE	18
4A	SYSTEMIC AND PULMONARY PUMPING SYSTEM	25
5A	THE CIRCULATORY SYSTEM	26
6A	THE KIDNEY	33
7A	THE CENTRAL NERVOUS SYSTEM	38
8A	MOVEMENT OF THE SPINE	43
9A	CROSS-SECTION OF THE SKIN	48
10A	STRUCTURE OF THE EAR	52
11A	ILLUSTRATION OF THE EYE	56
12A	FOREIGN OBJECTS IN THE EYE	58
	<u>SECTION B</u>	
1B	ROUTES OF ENTRY	71
2B	DOSE-RESPONSE RELATIONSHIP	74
3B	SOLVENT LABEL	82
4B	INDUSTRIAL DERMATITIS ON HANDS	86
5B	BURN CLASSIFICATIONS	87
6B	GENERAL CARE FOR CHEMICAL BURNS	88
7B	MAKEUP OF CLEAN, DRY AIR	90
8B	SOUND WAVES	108
9B	NOISE LEVELS	109
10B	HEARING DAMAGE	110
11B	TYPES OF NOISE	112
12B	WORK OUTPUT	114
13B	IN HOT WORK SITES, COOL DRINKING WATER CONTAINING 0.1 PERCENT SALT SHOULD BE USED	118
14B	RADIATION	123

FIGURE		PAGE
15B	NO SMOKING	126
16B	LIFTING	133

SECTION C

1C	PERSONAL SAMPLER READY FOR USE	141
2C	NOISE SURVEY PROCEDURE	142
3C(1)	HAND-HELD METHANE SPOTTER	145
3C(2)	MACHINE-MOUNTED METHANE MONITOR	145
3C(3)	HAND-HELD METHANE TESTER	146
3C(4)	MINER TESTING FOR METHANE	146
4C(1)	FLAME SAFETY LAMP	147
4C(2)	OXYGEN INDICATOR	148
5C(1)	ANEMOMETER	149
5C(2)	ANEMOMETER AIR MEASUREMENT	149
6C(1)	GRAVIMETRIC DUST SAMPLER	151
6C(2)	MRE GRAVIMETRIC RESPIRABLE DUST SAMPLER	152
7C	SOUND LEVEL METER	153
8C	NOISE DOSIMETER	153
9C	RADIOACTIVE RADON GAS BATTERY-OPERATED, PORTABLE PUMP	155
10C	SLING PSYCHROMETER	156
11C(1)	CARBON MONOXIDE TESTER	159
11C(2)	CARBON MONOXIDE LENGTH-OF-STAIN INSTRUMENT	159
12C(1)	PORTABLE LENGTH-OF-STAIN HYDROGEN SULFIDE DETECTOR	160
12C(2)	NITROGEN DIOXIDE DETECTOR	160
13C	DRAEGER MULTI-GAS DETECTOR	161
14C	MULTI-GAS DETECTOR	162
15C	USING WATER FOR WETTING DUST	168
16C	LOCAL EXHAUST VENTILATION	169
17C	EYE AND FACE SHIELDS	174
18C	EAR PROTECTION	175
19C	SUPPLIED-AIR TYPE RESPIRATOR	178

FIGURE		PAGE
20C	FILTER-TYPE RESPIRATORS	179
21C	HOW A RESPIRATOR WORKS	180
22C	PORTABLE SAFETY CAN	185
23C	CORRECT LIFTING	190
 <u>SECTION D</u>		
1D	ACCIDENT RATES	197
2D	FLAME SAFETY LAMP	204
3D	AN OXYGEN-DEFICIENT ATMOSPHERE WITH AN EXCESSIVE AMOUNT OF NITROGEN WILL NOT SUSTAIN LIFE	205
4D	THE SUPPLY OF OXYGEN THROUGH THE LUNGS INCREASES WITH AN INCREASE IN THE CARBON DIOXIDE (CO ₂) CONCENTRATION	206
5D(1)	EFFECTS OF CARBON MONOXIDE CONCENTRATIONS AND EXPOSURE TIME ON HUMANS	208
5D(2)	LONG-TERM EFFECTS OF CARBON MONOXIDE IN COMBINATION WITH THE HEMOGLOBIN OF THE BLOOD	208
6D	AIRBORNE RADIATION HAZARD	217
7D	EDUCATION!	222
8D	MINING-GENERATED DUST	224
9D	FACTORS THAT AFFECT HEARING	228
10D	ROCK DUSTING	234

INDUSTRIAL HYGIENE
FOR THE MINING INDUSTRY

SECTION A

"INDUSTRIAL HYGIENE AND THE HUMAN BODY"

Introduction

This course is about industrial hygiene. There are four sections in this particular course, and they must be completed in the order they are presented.

The book has been prepared in a programmed instruction format. Some characteristics of programmed instructional material that make it different from normal learning methods are:

1. The subject matter has been broken down into a series of easily-learned, small steps.
2. The student is given frequent opportunities to respond to the important points to be learned.
3. The student can immediately check his or her response to see if it is correct.

This method of providing written instruction was developed in the 1950's to answer the need to simplify the learning process and make it useful for self-paced, individual study.

The use of programmed instructional materials has proven to be an effective alternative to textbooks if the student responds to the questions and then checks the answer immediately.

Each subsection (paragraph or paragraphs between the lines) is called a frame. Each frame has a number and a letter located in the upper right-hand corner. This frame is number 1A which means it is the first frame in Section A.

As you work through this course, you will frequently be asked questions relating to the material that has been covered. The questions will be either true/false, multiple choice, matching, or fill-in-the-blank. Think carefully about each question and then record the best answer. The correct answer to the question will be given immediately following the question within the same frame, or, in the case of a review exercise, following the series of review questions.

WHERE WOULD AN ANSWER BE GIVEN TO A QUESTION ABOUT THIS FRAME? (CIRCLE THE CORRECT ANSWER)

- A. AT THE END OF SECTION A
- B. IN THE NEXT FRAME
- C. ON A DIFFERENT PAGE
- D. FOLLOWING THE QUESTION AND IN THE SAME FRAME

Answer: D

The purpose of this course is to introduce industrial hygiene, which deals with the recognition, measurement, evaluation, and control of various health hazards associated with modern industry, particularly, the mining industry. In order to learn as much as possible, always write your answers to the questions asked before looking at the correct answer. Remember, your knowledge and personal responsibility are the important keys to your good health.

TRUE OR FALSE

IF YOU ARE UNSURE OF THE CORRECT RESPONSE, CHECK THE CORRECT ANSWER AT THE END OF THE SECTION. _____

Answer: false

In order to better understand the effects of industrial health hazards, Section A of this course, "Industrial Hygiene and the Human Body," will define industrial hygiene and will also show the relationships between industrial hygiene and important functions of the human body.

TRUE OR FALSE

IN SECTION A, INDUSTRIAL HYGIENE WILL BE DEFINED WITHOUT SHOWING ANY RELATIONSHIPS TO THE FUNCTIONS OF THE HUMAN BODY. _____

Answer: false

Industrial Hygiene

What is industrial hygiene? Industrial hygiene is concerned with the health hazards or stresses present in a work environment and their effects on a worker's health. Health in this sense applies to complete physical, mental, and social well-being, not just the absence of disease. Health hazards or stresses can affect an individual immediately or slowly over a long period of time. Within the mining industry these health hazards can lead to skin, ear, eye, or lung problems for the worker.

6A

Specifically, industrial hygiene is concerned with the recognition, evaluation, and control of health hazards existing in the workplace. These hazards or stresses may cause sickness, impaired health and well-being, or significant discomfort and inefficiency among workers or among citizens of the community.

FILL IN THE BLANKS

INDUSTRIAL HYGIENE DEALS WITH THE CONTROL OF _____ HAZARDS. INDUSTRIAL HYGIENE IS ALSO CONCERNED WITH THE _____, _____, AND _____ OF THESE HAZARDS.

Answers: health; recognition, evaluation, and control

7A

Stress is defined as a chemical, physical, or emotional factor in the environment causing mental or physical tension and possibly disease or fatigue. What then are these environmental stresses? Well, they are grouped in four categories: chemical, physical, ergonomic, and biological. Each of these categories is examined in the frames that follow.

FILL IN THE BLANKS

ENVIRONMENTAL STRESS FACTORS ARE CLASSIFIED AS _____, _____, ERGONOMIC, AND _____.

Answers: chemical, physical, biological

Chemical stress usually exists when chemical substances in the air enter the lungs with the air we breathe (inhalation), or when chemical substances enter the body upon contact with the skin (absorption). Such hazardous chemical substances can also enter the body with food contaminated by a worker's dirty hands (ingestion). However, inhalation is the most critical due to the speed a chemical substance taken into the body in this way can be absorbed in the lungs, pass into the blood stream, and reach the brain and other organs.

FILL IN THE BLANKS

THE MOST CRITICAL WAY A SUBSTANCE ENTERS THE BODY IS BY _____. OTHER WAYS ARE THROUGH _____ AND _____.

Answers: inhalation; absorption, ingestion

Chemical substances in the air exist in many forms. Here are some definitions of those various forms.

- vapors - the gaseous form of substances that are normally solids or liquids (solvent vapors).
- gases - fluids with no shape that occupy space and can only be changed to a solid or liquid by increased pressure, reduced temperature, or both (methane).
- dusts - fine solid particles produced by industrial processes such as handling, crushing, grinding, or blasting (coal dust).
- fumes - fine solid particles suspended in the air as a result of heating metals (welding fumes).
- mists - fine liquid particles in the air resulting from condensation and produced when liquids are sprayed, bubbled, splashed, or foamed (cutting oil).
- smoke - fine particles that occur as the result of incomplete burning.
- aerosols - any fine liquid or solid particles small enough to remain in the air for a period of time.

CIRCLE THE CORRECT ANSWER

VAPORS, GASES, SMOKE, AND FUMES ARE EXAMPLE OF

- A. CHEMICAL HEALTH HAZARD
- B. ERGONOMIC HEALTH HAZARD
- C. PHYSICAL HEALTH HAZARD
- D. BIOLOGICAL HEALTH HAZARD
- E. NONE OF THE ABOVE

Answer: A

10A

When these chemical substances have harmful effects on the human body, they are said to be toxic. Some substances are more toxic than others. Chemicals are the most common environmental health hazard; therefore, an awareness of chemical toxicity can protect your health.

FILL IN THE BLANK

CHEMICAL SUBSTANCES THAT CAN HARM THE HUMAN BODY ARE CALLED _____ SUB-
STANCES.

Answer: toxic

11A

Physical stress, the second category of environmental stress, results from exposure to various extremes of pressure and temperature, mechanical vibration, radiation, and noise. Both chemical and physical stresses can be in various mining operations. As a result, they can produce harmful effects that can have an immediate or a long-term effect on the health of the worker.

CIRCLE THE CORRECT ANSWER

TWO TYPES OF PHYSICAL STRESSES ARE:

- A. FUMES, NOISE
- B. TEMPERATURE, GAS
- C. FATIGUE, RADIATION
- D. NOISE, VIBRATION

Answer: D

12A

Ergonomic stress, the third stress category, pertains to human factors associated with the physical and mental demands of a particular job. Many of these stress factors are internal; they arise from within the worker in response to the individual's perceptions of a particular task.

For example, fatigue may result when a worker is required to perform his or her duties in an uncomfortable or awkward position while working with coal mining equipment. Boredom or monotony may affect a worker's performance when the assigned task is highly repetitive. When workers worry about personal or job-related problems, their effectiveness on the job will probably suffer. Real or perceived pressure (from an employer, peer group, etc.) can also produce harmful effects. These and other ergonomic stress factors can threaten your health and safety.

FILL IN THE BLANK

WORRY, FATIGUE, AND BOREDOM ARE EXAMPLES OF _____ STRESS.

Answer: ergonomic

Thus far, three types of stresses have been discussed, chemical, physical, and ergonomic. The final stress category, biological stress, consists of stresses that are not found as often as others in the mining industry. Included as examples of things that cause biological stresses are fungi, bacteria, viruses, insects, rodents, and snakes.

FILL IN THE BLANK

FUNGI, VIRUSES, AND BACTERIA, ALTHOUGH NOT OCCURRING OFTEN IN THE MINING INDUSTRY, ARE EXAMPLES OF THINGS THAT CAUSE _____ STRESS.

Answer: biological

A worker in a mining operation is exposed to certain occupational diseases and hazards, as is any other worker in industry. It is, therefore, important to obtain a basic knowledge of industrial hygiene principles. In addition, it is important for individuals to take personal responsibility for their health. Management cannot do the job alone. If action is taken to eliminate health hazards, resulting safety hazards will automatically be eliminated too! For example, if noise levels are reduced, ease of communication would increase, thus reducing the possibility of accidents due to poor communication.

CIRCLE THE LETTER OF THE MOST CORRECT ANSWER

IT IS IMPORTANT TO HAVE A BASIC UNDERSTANDING OF INDUSTRIAL HYGIENE BECAUSE AS A WORKER IN A MINE, YOU WILL BE EXPOSED TO:

- A. DUST
- B. NOISE
- C. REPETITIVE MOTION
- D. GASES
- E. ALL OF THE ABOVE

Answer: E

As a means of review, the following chart might be helpful.

STRESS FACTORS CAUSING HEALTH PROBLEMS

<u>CHEMICAL</u>	<u>PHYSICAL</u>	<u>ERGONOMIC</u>	<u>BIOLOGICAL</u>
dusts	radiation	body position in	insects
fumes	noise	relation to task	rodents
mists	vibration	monotony	snakes
vapors	temperature	boredom	fungi
gases	pressure	repetitive motion	bacteria
aerosols		worry	viruses
smoke		work pressure	
		fatigue	

16A

Many of the stresses affecting miners have been mentioned. These stresses and other hazards can have a definite effect on a miner's continued health and well-being. Exposure to many of these stresses may produce immediate (acute) effects on the body or delayed (chronic) effects over longer periods of time. As stated previously, a program of industrial hygiene should consist of recognition and awareness of the health hazard, measurement and evaluation of the hazard, and control of the hazard. In addition, information concerning the possible hazards present in a work operation and process, provided in the form of education and training, should be available.

FILL IN THE BLANKS

STRESSES THAT PRODUCE AN IMMEDIATE EFFECT ON THE BODY ARE TERMED _____, WHILE THOSE PRODUCING A DELAYED EFFECT ARE CALLED _____.

Answer: acute, chronic

REVIEW

LET'S **PAUSE** AND REVIEW WHAT HAS BEEN COVERED TO THIS POINT SO YOU CAN EVALUATE YOUR PROGRESS.

1. INDUSTRIAL HYGIENE IS CONCERNED WITH THE _____, EVALUATION, AND _____ OF _____ HAZARDS.
 2. WHICH OF THE FOLLOWING FOUR CATEGORIES OF STRESS CAUSES THE LEAST PROBLEM FOR MINERS?
 - A. ERGONOMIC
 - B. CHEMICAL
 - C. BIOLOGICAL
 - D. PHYSICAL
 3. THE MAJORITY OF ALL ENVIRONMENTAL HEALTH HAZARDS INVOLVE WHICH FACTORS?
 - A. ERGONOMIC
 - B. CHEMICAL
 - C. BIOLOGICAL
 - D. PHYSICAL
 4. NOISE AND RADIATION ARE EXAMPLES OF
 - A. ERGONOMIC STRESS
 - B. CHEMICAL STRESS
 - C. BIOLOGICAL STRESS
 - D. PHYSICAL STRESS
 5. THE INTERACTION BETWEEN THE WORKER AND THE EQUIPMENT ON THE JOB WOULD BE AN EXAMPLE OF WHAT TYPE OF RELATIONSHIP?
 - A. ERGONOMIC
 - B. CHEMICAL
 - C. BIOLOGICAL
 - D. PHYSICAL
-

- Answers: 1. recognition, control, health
2. C
3. B
4. D
5. A

If the correct answers were not clear, review before moving ahead.

The Respiratory System

In order to understand the effects of industrial health hazards, it is necessary to know how certain parts of the body work, and what effect these health hazards have on the different organs and systems of the body.

The respiratory system is one of the most important routes of entry for harmful or toxic substances. Many occupational diseases result directly from the continued presence of toxic chemicals in the respiratory system. Other diseases are caused by passage of harmful substances through the lungs to the remainder of the body with the aid of the circulatory system and the blood.

The respiratory system brings oxygen into the body and then transfers it to the blood. The lungs also remove carbon dioxide from the blood and transfer it to the exhaled air.

CIRCLE THE CORRECT ANSWER

THE PRIMARY PURPOSE OF THE RESPIRATORY SYSTEM IS TO

- A. ALLOW OXYGEN TO ENTER THE BODY
- B. TRANSFER OXYGEN TO THE BLOOD
- C. REMOVE CARBON DIOXIDE WASTE
- D. ALL THE ABOVE

Answer: D

The respiratory system is composed of the nose, mouth, upper throat, larynx or voice box, trachea or windpipe, lungs, bronchi, diaphragm, and chest muscles. The respiratory system can further be divided into two areas. The first is the upper respiratory system, consisting of the airways - nose, throat, trachea, and the major air passages (bronchi) leading to the lungs. The second is the air sacs (alveoli) where the oxygen and carbon dioxide transfer takes place (see Figure 1A).

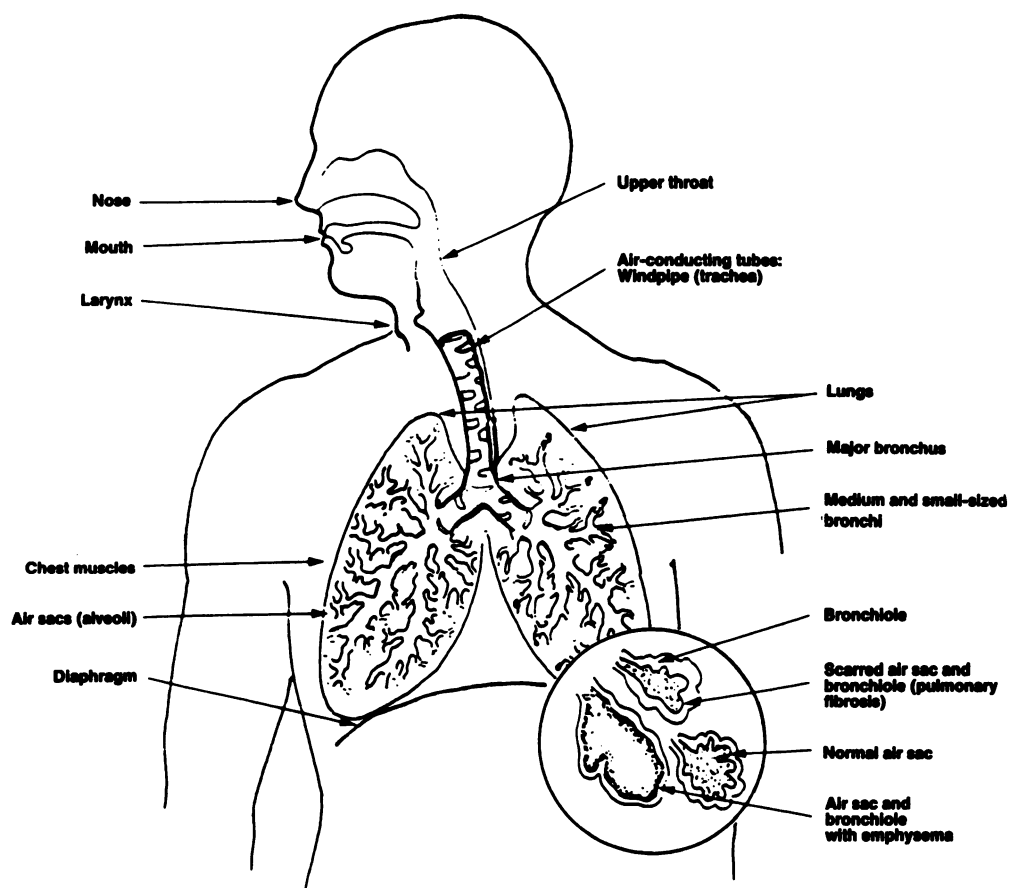


FIGURE 1A. RESPIRATORY SYSTEM

The respiratory system is a network of tubes so efficient that a person at rest, inhaling and exhaling about 15 times per minute, gets inhaled air to all parts of the lungs within two seconds. This network of tubes divides many times from one tube, the trachea (windpipe), to smaller and smaller tubes that end at the alveoli where the transfer of oxygen and carbon dioxide actually occurs.

CIRCLE THE CORRECT ANSWER

THE RESPIRATORY SYSTEM CAN SPECIFICALLY BE DIVIDED INTO TWO AREAS.

- A. NOSE AND LUNGS
- B. AIRWAYS AND BRONCHI
- C. AIR SACS AND AIRWAYS
- D. THE ALVEOLI AND AIR SACS
- E. BOTH C AND D ABOVE

Answer: C

21A

The nose, throat, windpipe (or trachea), and bronchi (smaller air tubes which branch out from the windpipe) make up the airways of the upper respiratory tract through which air must travel on the way to the air sacs in the lungs. Air which is breathed in must be filtered and humidified before reaching the alveoli in order to avoid injury to these delicate air sacs. The first step in this process is performed by the large hairs and moist mucous membranes of the nose.

FILL IN THE BLANKS

FILTERING AND HUMIDIFYING THE AIR BREATHED IN IS DONE BY THE LARGE _____
AND _____ MEMBRANES OF THE NOSE.

Answer: hairs, mucous

22A

In addition, there are other natural defenses in the upper respiratory system. The windpipe and bronchi have a lining of microscopic hairs called

cilia. There is also a coating of mucus produced by cells in the windpipe, bronchi, and bronchioles (tubes even smaller in size than the bronchi) that help trap dusts and other foreign particles. The purpose of the cilia is to act as a tiny conveyor system to move particles that have attached to the mucus up the respiratory tract to be expelled by the mouth or nose. This is referred to as the pulmonary escalation system. These bronchioles are also provided with tiny muscles which can close altogether in order to prevent air from reaching the air sacs. This happens when an individual is exposed, for example, to an extremely irritating gas, like sulphur dioxide. In effect, your body automatically refuses to breathe in the gas, and you hurry from the area of contaminated air, gasping for breath.

CIRCLE THE CORRECT ANSWER

THE BODY CAN ACTUALLY REFUSE TO BREATHE AN EXTREMELY IRRITATING GAS WHEN

- A. MICROSCOPIC HAIRS, CALLED CILIA, MOVE PARTICLES UP THE RESPIRATORY TRACT.
- B. TINY MUSCLES OF THE BRONCHIOLES CLOSE OFF THE RESPIRATORY PASSAGE TO THE AIR SACS.
- C. LARGE HAIRS BECOME COVERED WITH MOIST MUCUS.
- D. COUGHING, CHOKING, AND SNEEZING BEGIN.

Answer: B

The last two frames have dealt with the natural defenses available in the upper respiratory system. In addition to those already mentioned, two very common protective defenses have not yet been discussed - coughing and sneezing. Everyone coughs and sneezes, and this reaction also tends to get rid of irritants in the upper respiratory tract. These are defense mechanisms often forgotten.

FILL IN THE BLANKS

FIVE NATURAL DEFENSES IN THE UPPER RESPIRATORY SYSTEM ARE _____, _____, TINY MUSCLES, _____, AND _____.

Answer: sneezing, coughing, mucus, hair or cilia

Only particles of a certain size can even enter the lungs during breathing. The size of such particles is measured in terms of microns. One micron is 1/25,000 of an inch. For example, particles below 40 microns in size cannot be seen by the human eye. Although some particles 10 microns and smaller can enter the lungs, nearly all larger particles are trapped by the natural defenses of the nose, throat, larynx, trachea, or bronchi. Here they are swallowed or removed from the body by way of the mouth or nose.

FILL IN THE BLANKS

BECAUSE THE SIZE OF PARTICLES THAT CAN ENTER THE RESPIRATORY SYSTEM AND LUNGS ARE SMALL, THEY ARE MEASURED IN _____. MOST LARGER PARTICLES ARE REMOVED BY THE _____ OF THE UPPER RESPIRATORY SYSTEM.

 Answer: microns; natural defenses

To this point, we have examined the upper respiratory system. Let's turn attention now to the business district of the lungs, the air sacs.

In the lungs there are millions of tiny air sacs surrounded by blood. The air in these sacs is separated from the blood by a membrane so thin that gases can readily pass back and forth through it. There are two gases that are constantly being exchanged through these membranes: oxygen is passing from the air in the sacs into the blood, while carbon dioxide from the blood passes into the sac. Look at Figure 2A to get a better idea of what is happening.

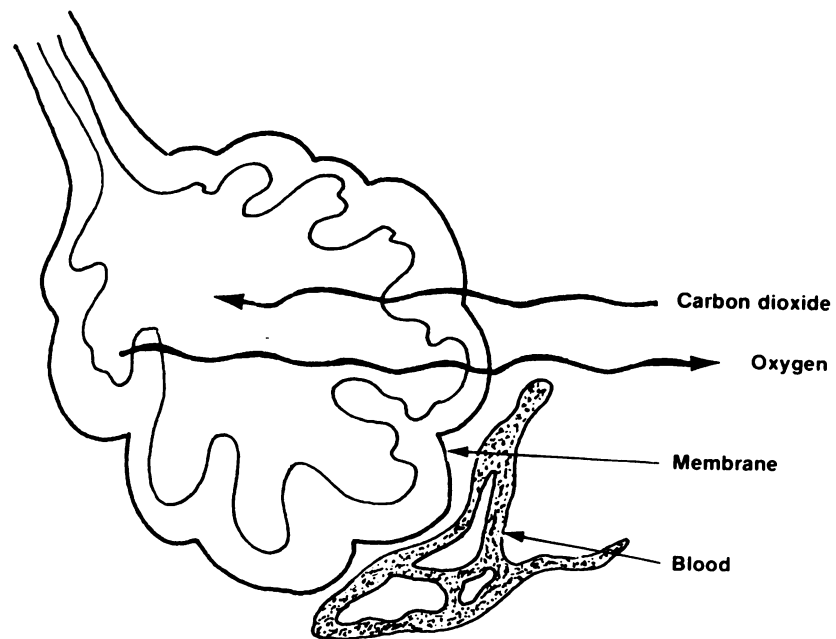


FIGURE 2A. AIR SAC

FILL IN THE BLANKS

THE MEMBRANE WALL OF THE AIR SAC IS SURROUNDED BY _____ WHICH IS
ESSENTIAL IN THE PROCESS OF _____ EXCHANGE.

Answer: blood, gas

Every time a breath is taken, air goes all the way down to the air sacs in the lungs. The oxygen then passes through the membrane wall of the air sac into the blood which surrounds it. The carbon dioxide, which is the waste gas given off by bodily processes, is carried by the blood to the lungs where it passes through the membrane to enter the air sac.

When you exhale, this carbon dioxide is ejected from the air sac to make room for more needed oxygen. This is how the breathing process works. Remember, a complete inhale-exhale cycle takes only a few seconds.

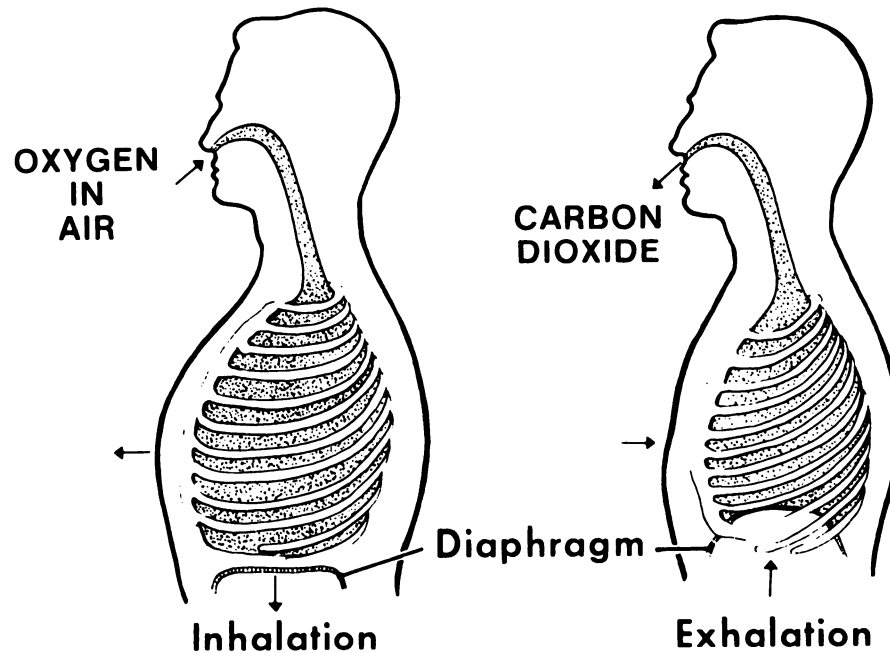


FIGURE 3A. BREATHING CYCLE

FILL IN THE BLANKS

THE EXCHANGE OF GASES IN THE LUNGS TAKES PLACE THROUGH THE MEMBRANE WALLS OF THE _____. WHEN YOU BREATHE, _____ ENTERS THE BLOODSTREAM THROUGH THE AIR SACS, AND A WASTE GAS, _____ ENTERS THE AIR SACS READY FOR REMOVAL WHEN YOU EXHALE.

Answer: air sacs; oxygen, carbon dioxide

In order for particles to enter the air sacs within the lungs, particles must usually be smaller than five microns in size. These particles are referred to as respirable. However, only particles smaller than $\frac{1}{2}$ micron are likely to enter the air sacs. This is the area where the lungs are most likely to receive damage.

The air sacs have two main defenses against these small particles. The lining of the air sacs is covered with a fluid-like substance for protection. Although this fluid is unlike the mucous lining of the upper respiratory airways, it accomplishes the same cleansing function. The second defense is provided by phagocyte cells, which are white blood cells that are able to surround and contain particles of this size.

FILL IN THE BLANKS

THE AIR SACS HAVE TWO MAIN DEFENSES, _____ AND _____
TO PROTECT THE LUNGS AGAINST PARTICLES SMALLER THAN FIVE MICRONS WHICH ARE
TERMED _____.

Answer: fluid, phagocyte cells, respirable

The sense of smell is also important to the respiratory system. There are cells located in the nose that are sensitive to odor. Since air must pass these odor-sensitive cells long before it reaches the air sacs located in the lungs, the body has a chance to detect a harmful substance. The reflex action of the body to stop breathing is its way of trying to protect the lungs. However, this defense is limited by the fact that these odor sensitive cells can lose their ability to detect any odor to which they have become accustomed. The term for this loss of smell is olfactory fatigue. It is for this reason that the sense of smell cannot be depended upon as a warning system in the working environment where unpleasant and irritating odors may be a normal part of the air in the atmosphere.

FILL IN THE BLANKS

AN INDIVIDUAL'S SENSE OF _____ CAN PLAY AN IMPORTANT PART IN PREVENTING
HARMFUL SUBSTANCES FROM ENTERING THE LUNGS UNLESS THE INDIVIDUAL HAS A CON-
DITION TERMED _____.

Answer: smell, olfactory fatigue

With the assistance of all these defense mechanisms, a healthy lung should be able to clean itself. However, if a substance is not removed from the air sac by any of the defense mechanisms that have been discussed, then a deposit may form in the air sac. Such deposits may or may not affect the lung. If, however, injury to the lung does occur, the degree and form of damage to the lung depends on the type of contaminant, its amount, and the period of a person's exposure.

Also, to make the job of self cleaning the lung more difficult, all the defense mechanisms that have been discussed are subject to deterioration and slowing down with age or bad health. Therefore, an older worker's lungs will not be able to cleanse themselves as fast or as well as those of a younger, healthier worker.

FILL IN THE BLANKS

THE PROTECTIVE EFFECT PROVIDED BY DEFENSE MECHANISMS IS REDUCED AND SLOWED DOWN BY _____ AND _____.

Answer: age, bad health

The most common forms of lung disease in this country are cancer, pneumonia, chronic bronchitis, and emphysema. In addition, coal workers' pneumoconiosis and silicosis are diseases common among miners. These diseases result from respirable dust retained in the lungs. These various diseases are the end result of a long series of small injuries to the lungs.

Chemicals that irritate the large and medium-sized tubes which conduct air to the lungs can be found in the environment. Each time these air tubes are irritated, mucus production is increased in an effort to dissolve, dilute, and remove the irritating substances. Due to this increased amount of mucus, an individual will develop a continuing cough trying to remove the mucus now present in the airways. This condition is called chronic bronchitis.

FILL IN THE BLANKS

A CONTINUING COUGH CAUSED BY AN INDIVIDUAL'S TRYING TO GET RID OF INCREASED MUCUS IN THE AIRWAYS RESULTS IN A CONDITION CALLED _____.

 Answer: chronic bronchitis

If such lung irritations are present day after day, the glands in the air tubes which produce mucus will increase their production regularly, even when the irritant is not present. Infections thrive in excess mucus. It is for this reason that irritation over a long period can easily lead to increased respiratory infections. From that point on it becomes a never-ending cycle: infections lead to more mucus production, and the mucus harbors bacteria which cause more infections. It is believed that repeated infections damage the small air tubes and probably the air sacs as well.

COMPLETE THE FOLLOWING SENTENCE

CHRONIC IRRITATION CAN EASILY LEAD TO INCREASED SUSCEPTIBILITY TO INFECTIONS BECAUSE _____.

 Answer: infections thrive in excess mucus

Emphysema is the serious disease which results when the delicate air sac walls are destroyed. Increased air pressure damaging the air sacs results in a breathing blockage when the air tubes fill with mucus. A breathing blockage can also be caused by direct pressure applied to the smaller tubes by their encircling muscles. This is what happens in asthmatic attacks. As a result, the air, which now cannot be exhaled, becomes trapped. This causes the blocked and narrow tubes to stretch and eventually break. As a result, large empty spaces, serving no purpose, develop in the lungs. These spaces cannot receive fresh air containing oxygen, nor can they discharge carbon dioxide. These parts of the lung, therefore, no longer function.

FILL IN THE BLANK

THE SERIOUS DISEASE WHICH RESULTS WHEN THE DELICATE AIR-SAC WALLS ARE DESTROYED THROUGH INFECTION OR INCREASED AIR PRESSURE IS _____.

 Answer: emphysema

35A

A condition that results from the air sacs filling with fluids is termed pulmonary edema. This fluid is produced in the lungs in a similar way that a blister forms in response to a burn. As a result of the air sacs being filled with fluid, they are not of much use in the transfer of oxygen. The lungs thus fill with liquids so an individual cannot breathe. Pneumonia is an example of a condition of this type.

FILL IN THE BLANKS

WITH AN INFECTION OF THE LUNGS CALLED PNEUMONIA, THE AIR SACS FILL WITH _____ WHICH EVENTUALLY STOPS THE TRANSFER OF _____.

Answer: fluid, oxygen

36A

Cancer is perhaps the disease that is feared most. A particular type, lung cancer, has been occurring more frequently during the last 10 years. Cells can change as a result of irritation or other factors. If this change is of a harmful kind, cancer will develop. When cancer cells grow, they interrupt the growth of normal cells and once this growth begins, it is hard to stop. Any substance that has been shown to cause cancer is called a carcinogen.

37A

However, some substances seem to have to be combined with others before they can cause cancer. Cigarette smoke is one of these substances and apparently is the largest single factor contributing to lung cancer. Cigarette smoke may or may not be a direct cause of cancer, but when it is combined with certain substances found in polluted air, a cancer-causing substance exists. This seems to be the case with uranium miners who smoke. In fact, few nonsmoking uranium miners have lung cancer. Other factors contributing to lung cancer may include air pollution from engines, industrial fumes, and specific materials such as asbestos and radioactive particles.

FILL IN THE BLANKS

A _____ CAUSES CANCER AND _____ APPARENTLY IS THE LARGEST SINGLE FACTOR CONTRIBUTING TO LUNG CANCER.

Answer: carcinogen, cigarette smoke

Another form of chronic lung disease is pulmonary fibrosis. The term pulmonary fibrosis means lung scarring. Although not common among the general population, it does occur frequently among groups of people who are exposed to certain dusts and chemicals. Pneumoconiosis results from the inhalation of dust and the reaction to the dust. With this in mind, it is obvious that everyone, no matter what his or her occupation, will have some degree of pneumoconiosis.

Silica dust causes a typical example of lung scarring called silicosis. Lungs in this condition are not able to destroy or remove collected silica dust. The lung's reaction, therefore, is to produce a large amount of scar tissue. This process is called fibrosis and will eventually cause disability. The scar tissue is located mainly in the walls of the air sacs, causing a decrease in the oxygen content of the blood. Without a good supply of oxygen, the organs of the body cannot work properly. Silicosis is found among hard coal miners and, to some extent, among soft coal miners. But it also can be found among those who dig for copper, lead, zinc, silver, gold, and those who work at surface sand and gravel operations. It is also found among those who cut granite out of mountains.

FILL IN THE BLANKS

A SPECIFIC TYPE OF LUNG SCARRING OR _____ CAUSED BY SILICA DUST IS CALLED _____.

Answer: pulmonary fibrosis, silicosis

Breathing coal dust over a long period of time can cause another form of lung scarring and disability known as Coal Workers' Pneumoconiosis (CWP or "Black Lung"). In coal mining, increased exposure to coal dust year after year will increase the amount of pneumoconiosis in an individual's lungs. In this situation, the lungs actually harden, becoming nonfunctional, as a result of dust inhalation. In fact, it is believed that there may be as many as 125,000 individuals with Coal Workers' Pneumoconiosis in the United States.

FILL IN THE BLANKS

BREATHING COAL DUST OVER THE YEARS CAN CAUSE A FORM OF LUNG SCARRING CALLED _____.

Answer: Coal Workers' Pneumoconiosis

One other type of lung scarring results from breathing in asbestos fibers that have escaped into the air, specifically in areas where individuals are working with the substance. The disease that results, asbestosis, can result from either long- or short-term exposure. The seriousness of the problem is obvious considering that there are some 200,000 industry workers associated with asbestos products and fibers. The exposure that results is believed to be responsible for 2,000 deaths each year from either asbestosis or cancer. Also, it is important to note that the risk of developing lung cancer is much greater for asbestos workers who smoke.

FILL IN THE BLANKS

INHALATION OF ASBESTOS FIBERS CAUSES A LUNG SCARRING DISEASE CALLED _____. THREE TYPES OF PULMONARY FIBROSIS OR LUNG SCARRING ARE _____, _____, AND _____. BECAUSE THEY ARE CAUSED BY DUST INHALATION, THEY ARE ALL TYPES OF _____.

Answer: asbestosis; silicosis, coal workers' pneumoconiosis, asbestosis; pneumoconiosis

Over the years, repeated exposure to irritating substances affecting the lungs creates what is known as a cumulative effect on an individual. Cumulative effect simply means that each harmful exposure adds to the effect of the previous exposure. Such an effect will eventually take its toll so that in the final stages the lungs will be unable to supply enough oxygen or remove carbon dioxide from the body. As a result, other organs of the body, such as the heart, will not be able to function normally.

FILL IN THE BLANKS

WHEN EACH HARMFUL EXPOSURE ADDS TO THE EFFECT OF THE PREVIOUS EXPOSURE, A _____ IS SAID TO OCCUR.

Answer: cumulative effect

Cardiovascular System

Now that we've spent some time on the respiratory system, let's look at the heart and blood vessels or the cardiovascular system.

The heart pumps blood to all parts of the body in two pumping systems: one from the right side of the heart (pulmonary) and one from the left side (systemic). All of the blood pumped from the right side of the heart goes to the Lungs where it deposits the carbon dioxide that it has picked up from the tissues and receives a new supply of oxygen. The blood then travels to the left side of the heart where it is pumped to the rest of the body.

As shown in Figure 4A, the blood first is pumped through the pulmonary system, and then through the systemic pumping system. This alternation between the two systems is continuous.

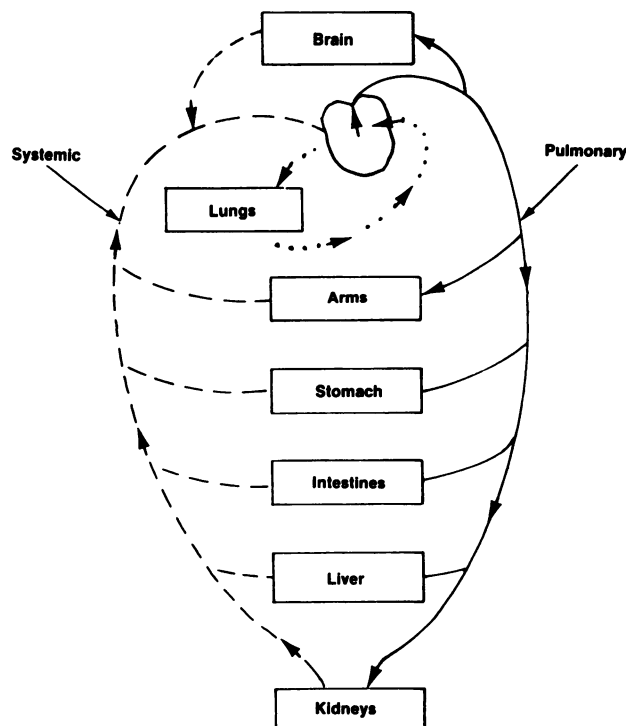


FIGURE 4A. SYSTEMIC AND PULMONARY PUMPING SYSTEMS

FILL IN THE BLANKS

THE CARDIOVASCULAR SYSTEM PUMPS BLOOD TO THE BODY THROUGH THE _____ PUMPING SYSTEM OR RIGHT SIDE OF THE HEART AND THE _____ PUMPING SYSTEM OR LEFT SIDE OF THE HEART.

Answer: pulmonary, systemic

The blood vessels are a series of branching tubes that carry blood throughout the body. Arteries carry blood with oxygen from the lungs to the cells of the body and the veins carry blood back to the heart and lungs. The thin walls of the smallest blood vessels, the capillaries, allow substances such as oxygen to be exchanged from the blood to the body tissues, and waste products to be returned to the lungs and kidneys for removal from the body. A buildup of waste products, lack of oxygen, or heat can cause these blood vessels to get larger or dilate. Narrowing or constriction of these same vessels can be caused by such things as noise, nicotine from cigarettes, or cold temperatures. As a result, more blood would flow through a dilated rather than through a constricted blood vessel.

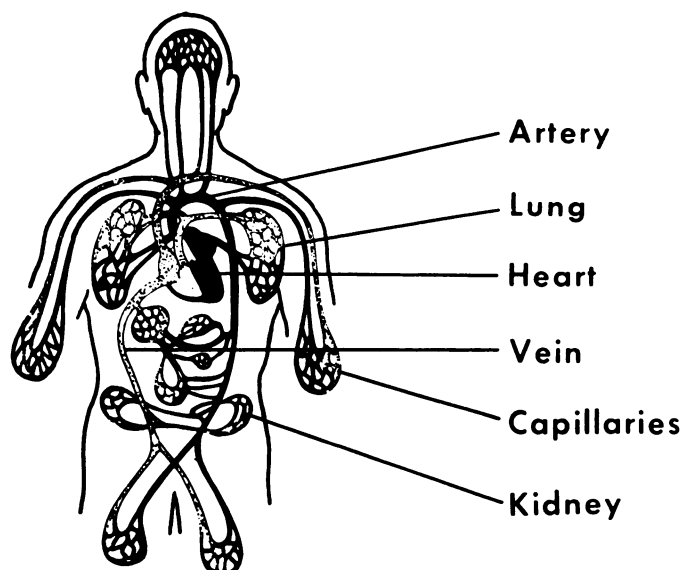


FIGURE 5A. THE CIRCULATORY SYSTEM

WHICH OF THE FOLLOWING CAUSE DILATION OF THE BLOOD VESSELS?

- A. SMOKING
- B. NOISE
- C. LACK OF OXYGEN
- D. WORKING IN EXTREME COLD TEMPERATURES

Answer: C

The heart is nothing more than a muscle. Its job is to beat (contract rhythmically) 60 to 100 times a minute pumping blood through all the blood vessels in the body keeping the body alive. In order to do this job, the heart needs a constant supply of oxygen and in order to deliver the oxygen to the body, the heart can never stop pumping. Therefore, the working relationship between the heart and lungs is very important. Together they form the cardio-pulmonary system.

FILL IN THE BLANKS

IN ORDER TO DO ITS JOB, THE HEART NORMALLY BEATS _____ TIMES PER MINUTE AND, WITH THE LUNGS, FORMS THE _____ SYSTEM.

Answer: 60-100, cardio-pulmonary

Blood is a solution which contains substances used by the body as well as waste that the body eventually eliminates. In addition to carrying oxygen and carbon dioxide waste, the blood also has the duty of passing through the digestive system where it picks up digested food and takes it to the cells of the body. It then passes through the kidneys, which filter out waste products.

The blood contains white blood cells which fight infection and red blood cells which carry oxygen, as well as platelets that begin the blood-clotting process. The red blood cells also contain hemoglobin, which has the ability to gather large quantities of oxygen from the air in the lungs, carry it to the other parts of the body, and deposit it where needed. The blood's job of transporting oxygen throughout the body is very important. The organs of the body, particularly the brain, heart, and kidneys, cannot survive and function when they are not supplied with oxygen.

FILL IN THE BLANKS

IN ADDITION TO CARRYING OXYGEN AND ELIMINATING WASTE, THE BLOOD CONTAINS _____ BLOOD CELLS THAT FIGHT INFECTION AND _____ THAT AID IN THE BLOOD CLOTting PROCESS. HEMOGLOBIN IS RESPONSIBLE FOR CARRYING _____ AND IS FOUND IN THE _____ BLOOD CELLS.

Answer: white, platelets; oxygen, red

Blood vessels, also, can be damaged if they do not get oxygen. For example, this occurs when a person inhales cigarette smoke. The carbon monoxide found in the smoke becomes firmly attached to the hemoglobin making it unable to carry oxygen. This occurs because carbon monoxide attaches to hemoglobin 300 times faster than oxygen does. If a high concentration of carbon monoxide happens to be present in the working environment of a mine, a great amount of an individual's hemoglobin could possibly become bound to it, making the blood unavailable for carrying any oxygen. The body then becomes starved for oxygen. If the condition lasts for more than a few minutes, the person may die. In reality, carbon monoxide poisoning could actually be called hemoglobin poisoning.

FILL IN THE BLANKS

HEMOGLOBIN ABSORBS _____ 300 TIMES FASTER THAN OXYGEN AND LACK OF _____ MAY LEAD TO DEATH. CARBON MONOXIDE POISONING MIGHT ACTUALLY BE THOUGHT OF AS _____ BECAUSE _____ IS UNABLE TO CARRY OXYGEN IN THE PRESENCE OF THIS GAS.

 Answer: carbon monoxide, oxygen; hemoglobin poisoning, hemoglobin

Certain chemicals can damage the red blood cell and cause the cell to rupture. When the cell ruptures, large amounts of hemoglobin are released into the bloodstream, which possibly can cause damage to the kidneys.

Depending on the chemical cause and the level of exposure, the red blood cells may rupture either slowly or rapidly. When these cells rupture slowly, the symptoms are like those of anemia caused by a deficiency in the oxygen-carrying material in the blood: weakness, fatigue, dizziness, headache, and a pale complexion. Sometimes the victim's skin will also display a yellowish color (jaundice). When the red blood cells rupture rapidly, the victim develops severe anemia. This may leave an insufficient number of red blood cells to carry oxygen to the brain, heart, and kidneys. Lack of oxygen to these organs may then complicate the illness and may be fatal.

FILL IN THE BLANKS

A RUPTURE OF THE RED BLOOD CELLS FROM EXPOSURE TO DANGEROUS LEVELS OF CERTAIN CHEMICALS CAUSES THE BODY TO LOSE _____, RESULTING IN _____.

 Answer: oxygen, anemia

Bone marrow, the soft material that fills the inside of the bone, produces a constant supply of red blood cells, white blood cells, and platelets. This bone marrow can be damaged by chemicals or by exposure to X-rays or a harmful kind of radiation such as ionizing radiation used in nuclear gauges found at preparation plants. If the bone marrow is damaged, it is unable to produce a sufficient supply of blood cells. This can result in severe anemia due to the lack of red blood cells, recurrence of serious infections due to the lack of white blood cells, and uncontrollable bleeding due to the lack of platelets.

FILL IN THE BLANKS

RED BLOOD CELLS, WHITE BLOOD CELLS, AND PLATELETS ARE PRODUCED IN THE

_____.

Answer: bone marrow

50A

Another problem related to the circulatory system is heart attack. Diseases of the heart are the number one cause of death in the United States. A common cause of heart attack is hardening of the arteries of the heart (coronary arteriosclerosis). Over a period of 20 to 30 years, patches called plaques containing cholesterol (a type of fat found in food and also produced by the body) begin to line the small blood vessels which supply the heart with blood. The arteries become stiff and more narrow leading to total blockage over a period of time. When completely blocked, the arteries can no longer supply oxygen to certain parts of the heart, causing damage or complete destruction to that part. When this happens, a heart attack occurs. It depends, however, on how much of the heart is damaged or destroyed as to how well the rest of the heart can get along with the loss.

51A

A diet that contains a lot of animal fat, cream, and butter (saturated fat) causes an increase in the amount of cholesterol in the blood. It is also believed that carbon monoxide found in cigarette smoke and in mine air where diesel machinery is used helps speed up the formation of cholesterol plaques.

An individual's diet and personal habits, therefore, become very important in preventing heart disease.

FILL IN THE BLANKS

WHEN THE ARTERIES CAN NO LONGER SUPPLY OXYGEN TO CERTAIN PARTS OF THE HEART,
 A _____ OCCURS. IT IS BELIEVED _____ AND _____
 _____ ARE VERY IMPORTANT IN PREVENTING HEART DISEASE.

 Answer: heart attack; diet, personal habits

If enough of the heart muscle has been damaged by a heart attack, the heart will not be able to effectively pump blood to other parts of the body. This happens when the undamaged part of the heart is unable to take over and make up for the damaged part. The condition that occurs in this situation is congestive heart failure, which can cause death.

FILL IN THE BLANKS

IF THE HEART CANNOT PUMP ENOUGH BLOOD TO THE PARTS OF THE BODY BECAUSE OF
 DAMAGE TO PART OF THE HEART MUSCLE, _____
 OCCURS, WHICH CAN CAUSE DEATH.

 Answer: congestive heart failure

The heart muscle can also be damaged if it has to pump blood through narrowed blood vessels. Blood vessels in the lungs can become narrowed when scar tissue is formed as a result of chronic lung disease. Narrowing of the small blood vessels in the rest of the body can also be the result of such things as exposure to noise. The narrowing of the blood vessels makes it harder for the blood to flow, resulting in high blood pressure and a bigger workload for the heart. If this condition is present over a long period of time, it could cause the heart to wear out more quickly than it would under normal conditions.

FILL IN THE BLANKS

THE HEART WILL ALSO TEND TO WEAR OUT FASTER IF THE BLOOD VESSELS LEADING TO
 THE PARTS OF THE BODY ARE _____.

 Answer: narrow

REVIEW

LET'S REVIEW THE FUNCTION OF THE LUNGS AND HEART.

1. THE AIR SACS AND THE AIRWAYS MAKE UP THE _____ SYSTEM.
 2. MUCUS, HAIRS OR CILIA, AND MUSCLES OF THE BRONCHIOLES ARE ALL _____ OF THE UPPER RESPIRATORY SYSTEM.
 3. THE AREA OF THE LUNGS MOST LIKELY TO RECEIVE DAMAGE FROM HARMFUL SUBSTANCES IS THE _____.
 4. WHICH OF THE FOLLOWING IS A SPECIFIC DISEASE OF THE RESPIRATORY SYSTEM?
 - A. BRONCHITIS
 - B. PNEUMONIA
 - C. PNEUMOCONIOSIS
 - D. ALL THE ABOVE
 5. THE LARGEST SINGLE FACTOR CONTRIBUTING TO LUNG CANCER IS
 - A. DRINKING
 - B. CIGARETTE SMOKING
 - C. COAL DUST
 - D. FIBROSIS
 6. THE _____ CARRY BLOOD TO THE BODY AND THE _____ RETURN BLOOD TO THE HEART.
 7. THE SUBSTANCE FOUND IN THE RED BLOOD CELLS THAT CARRIES OXYGEN IS CALLED _____.
 8. CARBON MONOXIDE FOUND IN MINES USING DIESEL EQUIPMENT CAUSES A LACK OF _____ IN THE BLOOD.
 9. WHITE BLOOD CELLS FIGHT _____ BY MAKING ANTIBODIES AND ALSO CONTAIN _____ THAT HELP THE BLOOD TO CLOT.
 10. A CONDITION THAT OCCURS WHEN THE HEART IS UNABLE TO PUMP BLOOD EFFECTIVELY TO ALL PARTS OF THE BODY IS
 - A. MUSCLE FATIGUE
 - B. CONGESTIVE HEART FAILURE
 - C. CARDIO-PULMONARY FAILURE
 - D. HEART FAILURE
-

- Answers:
- | | |
|------------------------|-------------------------|
| 1. respiratory | 6. arteries, veins |
| 2. natural defenses | 7. hemoglobin |
| 3. alveoli or air sacs | 8. oxygen |
| 4. D | 9. infection, platelets |
| 5. B | 10. B |

If the correct answers were not clear, review before moving ahead.

Liver Function

The liver is located just below the rib cage in the upper right corner of the abdomen. It is actually the chemical factory of the body receiving all the blood from the intestines and destroying or changing harmful substances in the blood to harmless ones. The liver works to neutralize harmful chemicals that enter the body as well as chemicals produced by the body when the body no longer needs them. A liver that cannot function, therefore, cannot do this important job.

Hepatitis, or inflammation (soreness) of the liver, can be caused by a virus or various chemicals and drugs. The various kinds of hepatitis usually do not create long lasting effects on the body. However, a severe case of hepatitis can result in a scarring of the liver called cirrhosis. Most commonly, however, liver scarring is the result of drinking excessive amounts of alcohol. If there is enough scarring to hinder the normal function of the liver, it will not be able to do the chemical work required by the body, and the level of toxic or harmful substances will build up in the body causing injury, illness, and possible death.

FILL IN THE BLANKS

CERTAIN CHEMICALS MAY CAUSE AN INFLAMMATION OF THE LIVER KNOWN AS _____, AND _____ OF THE LIVER MAY RESULT, MAKING THE LIVER UNABLE TO FUNCTION NORMALLY AND POSSIBLY LEADING TO DEATH.

Answer: hepatitis, cirrhosis or scarring

Kidneys

The blood stream carries a variety of substances which are products of the chemical processes of the body. In order for good health to be maintained, all of these substances must be kept in the proper balance. For these reasons, let's now focus attention on the body's filtering system, the kidneys.

The kidneys provide a delicate and sophisticated filtering system for the body and are responsible for maintaining this proper chemical balance in the blood. Since the kidneys filter all substances in the blood, these organs may be seriously injured by many harmful chemicals which pass through the body. The general appearance of the kidneys is shown in Figure 6A.

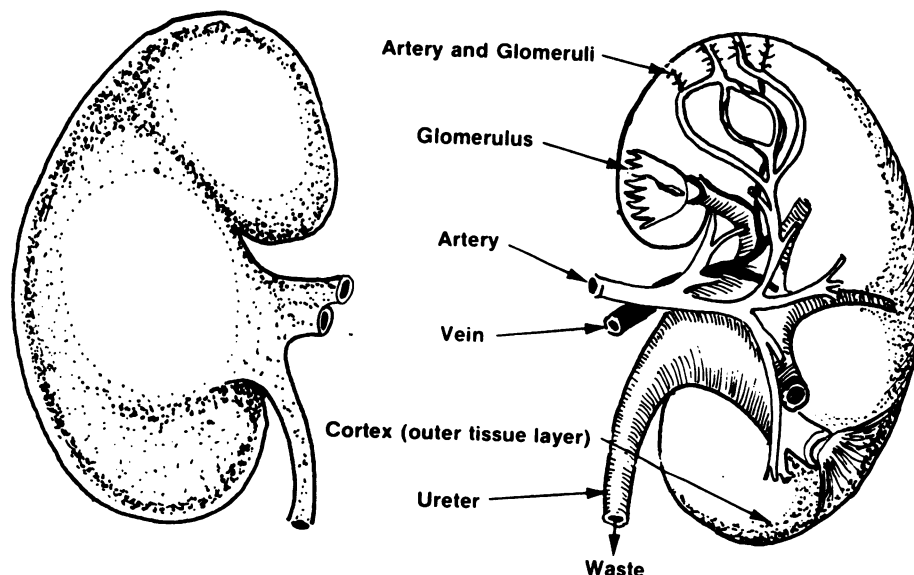


FIGURE 6A. THE KIDNEY

FILL IN THE BLANK

THE _____ ARE RESPONSIBLE FOR FILTERING THE BLOOD AND MAINTAINING PROPER CHEMICAL BALANCE.

 Answer: kidneys

The two kidneys are each about 5 inches long and 2 inches wide and are located in the back just below the rib cage. Each one contains over a million microscopic filters, called glomeruli, through which the blood circulates. These filters separate all of the water and salts from the bloodstream and collect the water and salt mixture, called urine, in the kidney.

Once the filters do their job, the urine passes from the filters into small, long coiled tubes called tubules. The urine, however, still contains sugar that the cells of the tubules must now put back into the blood. These cells remove the sugar and chemicals from the urine by acting like a chemical pump, and in this way the kidneys are able to maintain the proper balance needed to keep the body healthy. The tubules then lead into a single tube leading to the bladder where the urine remains prior to elimination from the body.

FILL IN THE BLANK

TUBULES HAVE THE JOB OF REMOVING CHEMICALS FROM THE _____.

Answer: urine

The symptoms of kidney disease are often vague and termed nonspecific, meaning that a doctor is often unable to definitely decide on the cause of the illness. For example, high blood pressure may occur if the kidneys cause increased levels of salt and water accumulation in the body, possibly leading to heart strain and heart failure. An increased salt level can also cause edema (swelling) due to the accumulation of fluid in body tissues. A particular type, pulmonary edema, is the accumulation of fluid in the lungs.

FILL IN THE BLANK

THE SYMPTOMS OF KIDNEY DISEASE CAN BE TRICKY IN THAT THEY ARE _____.

Answer: nonspecific

Some chemicals may directly poison the kidney. It was said before that the function of tubules in the kidneys is to remove harmful chemicals, but by doing this job, the tubules are exposed to high concentrations of these chemicals and can be poisoned. Kidney poisoning may appear within a few hours after exposure, or possibly not for days following contact with harmful chemicals. Poisoning of the kidney may cause a person to stop urinating, or allow passage of only a few drops a day. All functions that the kidney normally carries out are thus affected, and congestion results from the accumulation of fluid. Uremia is the name given to the condition that occurs when chemicals produced by the body are allowed to build up. This condition can lead to death.

FILL IN THE BLANKS

HARMFUL CHEMICALS CAN _____ THE KIDNEYS AND IF A BUILDUP OF FLUID DEVELOPS, A SERIOUS CONDITION CALLED _____ CAN LEAD TO DEATH IF NOT TREATED.

Answer: poison, uremia

Industrial chemicals and industrial accidents can also cause kidney disease. There are several types of kidney disease, each of which may result in the loss of part or all of the kidney's functions.

Loss of circulation to the kidneys is one important cause of acute or immediate kidney damage. Kidneys, like the heart, function continuously and require a constant supply of blood and oxygen. Major injuries that result in loss of blood, low blood pressure, or poor circulation may cause a lack of circulation and oxygen. Carbon monoxide is an industrial chemical that prevents the circulation of oxygen and may result in kidney damage.

Heat exposure can also cause changes in circulation resulting in more blood going to the skin and less blood to the kidneys. This can result in kidney damage if the change is great or if it occurs too fast. Heavy exercise causes more blood to go to the muscles, but this change is generally not harmful to healthy young workers. Heavy exercise, however, does increase the risk of kidney damage for older persons. Also, individuals with mild kidney damage may suffer further damage as a result of heavy exercise.

FILL IN THE BLANKS

INDUSTRIAL CHEMICALS AND INDUSTRIAL ACCIDENTS MAY CAUSE IMMEDIATE KIDNEY DAMAGE DUE TO _____.

 Answer: loss of circulation

64A

Certain chemicals and injuries can break up the red blood cells and release hemoglobin into the bloodstream causing immediate damage to the kidney. Under normal conditions, hemoglobin is prevented from entering into the kidney tubes by the membrane surrounding the red blood cells. When these cells rupture, hemoglobin is released into the bloodstream and is able to enter the kidney tubules. The hemoglobin then forms a clump blocking the tubes and stopping the formation of urine and the body's ability to eliminate this waste product.

FILL IN THE BLANKS

AS A RESULT OF CERTAIN CHEMICALS AND INJURIES, THE RED BLOOD CELLS CAN RELEASE _____ INTO THE BLOODSTREAM WHICH THEN ENTERS THE KIDNEYS CAUSING _____ OF THE TUBES.

 Answer: hemoglobin, blockage

65A

Problems that may result in chronic or long-term kidney disease then fall into three categories. The first is injury to large and medium-sized blood vessels, which may decrease circulation to the kidneys. The second category involves damage to the kidney tubes, often the result of an injury or illness. The third problem is high blood pressure, which can cause damage to the small and medium-sized blood vessels of the kidneys. High blood pressure is the result of blood vessels that become thickened and narrowed. The kidney then suffers damage from the decreased blood flow.

FILL IN THE BLANKS

BLOOD VESSELS THAT BECOME NARROWED CAUSE _____, WHICH CAN CAUSE LONG-TERM (CHRONIC) KIDNEY DISEASE.

 Answer: high blood pressure

REVIEW

LET'S BRIEFLY REVIEW THE INFORMATION CONCERNING THE LIVER AND KIDNEYS.

1. THE LEVEL OF HARMFUL CHEMICAL SUBSTANCES IN THE BLOOD CAN BE REDUCED BY THE CHEMICAL FACTORY OF THE BODY OR THE _____.
2. WHICH OF THE FOLLOWING IS A DISEASE OF THE LIVER?
 - A. DERMITITIS
 - B. HEPATITIS
 - C. CIRRHOSIS
 - D. BOTH B AND C
3. THE MAIN JOB OF THE KIDNEYS IS TO ACT AS A _____ SYSTEM, KEEPING A PROPER CHEMICAL BALANCE IN THE BLOOD.
4. THE KIDNEYS GET RID OF WASTE IN THE FORM OF _____ AND IN THIS WAY THEY ARE ABLE TO MAINTAIN THE PROPER BALANCE NEEDED TO KEEP THE BODY HEALTHY.
5. KIDNEY DAMAGE CAN BE CAUSED BY
 - A. HIGH BLOOD PRESSURE
 - B. CHEMICALS
 - C. INDUSTRIAL ACCIDENTS
 - D. ALL THE ABOVE

Answers: 1. liver
2. D
3. filter
4. urine
5. D

If the correct answers were not clear, review before moving ahead.

Central Nervous System

In order for an individual to work or even exist from minute to minute, the body must never cease performing its mechanical functions, such as breathing. Besides performing these mechanical functions, an individual must be able to think, experience emotions, and respond to the environment. The nervous system controls all these complicated jobs that the mind and body perform, often while a person remains unaware that these controls are operating. In other words, the nervous system is the control center for the body, letting organs and muscles know when to do something.

68A

The nervous system can be broken down into different parts. First, there is the central nervous system which is made up of the brain and the spinal cord; this is the control center of the body. Originating from the brain are 12 pairs of cranial nerves that control vision, the way the eyes work, the senses of smell and hearing, as well as several other functions. These cranial nerves branch out and connect with other nerves extending throughout the body. The spinal cord, an extension of the brain, has 31 pairs of nerves that extend and divide throughout the limbs, organs, muscles, and skin. This system is pictured in Figure 7A.

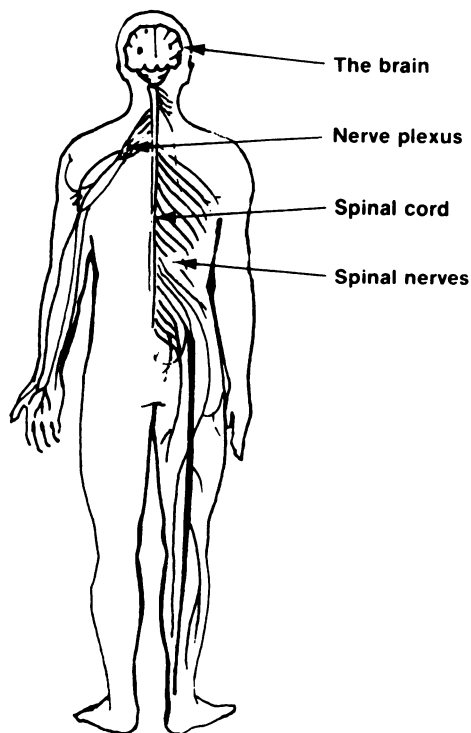


FIGURE 7A. THE CENTRAL NERVOUS SYSTEM

FILL IN THE BLANKS

THE CENTRAL NERVOUS SYSTEM, THE CONTROL CENTER OF THE BODY, IS MADE UP OF THE _____ AND THE _____.

 Answer: brain, spinal cord

69A

The nerves that leave and reenter the central nervous system reach every part of the body; this system is called the peripheral nervous system. These nerves are assembled in bundles called plexuses when they leave the spinal cord, but then branch out in a definite pattern to the back, sides, and front of the body.

These nerves must also extend through the body to every muscle, since all activity of the body is controlled by nerve signals. For example, the peripheral nerves that branch from the bundle of nerves in the shoulder area affect the skin and muscles of the shoulder and arm allowing them to move. All of the muscles that permit body movement, from turning your head back and forth to moving your little finger up and down, are controlled by the peripheral nervous system.

FILL IN THE BLANK

THE NERVES THAT SUPPLY THE SKIN, MUSCLES OF THE ARMS AND LEGS, AND THE SHOULDER ARE PART OF THE _____ NERVOUS SYSTEM.

 Answer: peripheral

70A

The brain and spinal cord are capable of sending and receiving messages. For example, if you touch something hot, the peripheral nerves transmit information to the spinal cord and brain, which then transmits information back to the affected area along other peripheral nerves causing certain muscles to expand or contract. As a result, your body is told to pull away from the hot object. Those peripheral nerves that carry messages from the central nervous system are called motor nerves, while those returning messages to the central nervous system are called sensory nerves.

FILL IN THE BLANKS

PERIPHERAL NERVES THAT RETURN MESSAGES TO THE BRAIN ARE CALLED _____
 NERVES WHILE THOSE THAT SEND MESSAGES TO MUSCLES AND ORGANS ARE CALLED
 _____ NERVES.

 Answer: sensory, motor

71A

Nerve messages transferred by means of chemicals and without a person's awareness occur through what is called the autonomic nervous system.

There are two divisions of the autonomic nervous system. The first part is concerned with responses to stress and is called the sympathetic nervous system. As the name implies, this part of the system responds in sympathy with an individual's surroundings and feelings. For example, the sympathetic nervous system of a person subjected to a very loud noise (a stressful situation) will quicken the person's heartbeat making the heart work harder. This occurs because the muscles that enlarge or decrease the size of the blood vessels are controlled by sympathetic nerves. Sensory nerves thus activate a response.

The second part of the autonomic nervous system is called the parasympathetic nervous system. The purpose of this system is to stimulate digestion, empty the bladder, cause mucous secretion, and decrease the heartbeat.

FILL IN THE BLANKS

THE _____ NERVOUS SYSTEM USES CHEMICALS TO CARRY MESSAGES WITHOUT A PERSON'S AWARENESS OF THE PROCESS. THE _____ NERVOUS SYSTEM AIDS DIGESTION, AND THE _____ SYSTEM RESPONDS TO THINGS SUCH AS AN INDIVIDUAL'S FEELINGS.

 Answer: autonomic; parasympathetic, sympathetic

72A

Injury to the central nervous system is permanent. Once damaged, neither the brain nor the spinal cord can repair itself. However, damage to the peripheral nerves can sometimes be corrected. Chemicals can change or destroy nerve functions, and paralysis may be the result. But if exposure to certain chemicals is stopped in time, these effects can be reversed. Long-term chemical exposure, on the other hand, may lead to permanent damage.

FILL IN THE BLANKS

DAMAGE TO THE _____ NERVOUS SYSTEM IS PERMANENT WHILE DAMAGE TO THE
 _____ NERVES CAN SOMETIMES BE CORRECTED.

 Answer: central, peripheral

In spite of all this, the most delicate and most vital part of the body is the brain. Symptoms of dizziness and drowsiness initially indicate that a harmful substance is interfering with the proper function of the central nervous system. For example, suppose that a worker's reflexes are dulled. When a worker begins to feel dizzy or drowsy, the brain is acting like an alarm system, trying to tell him that things that should not be there are entering his body and that they are affecting the way the body works. It is important, therefore, to pay attention to warning signals given by your body; it could save your life!

FILL IN THE BLANKS

THE BRAIN ACTS AS AN _____ SYSTEM AND IS ABLE TO GIVE THE BODY
 _____ THAT CAN SAVE A LIFE.

 Answer: alarm, warning signals

Musculo-Skeletal System

In addition to the systems already mentioned, the body also needs a structural support system. The musculo-skeletal system, made up of bones and muscles, holds the body erect and together. This system performs the same function as the steel framework supporting a building and is made up of several parts, each with a different function.

- The bones give the body structure.
- Joints are located between the bones and work somewhat like ball bearings, allowing the bones to move freely.
- Ligaments hold the bones together.
- Tendons firmly hold the muscles to the bones.

FILL IN THE BLANKS

THE _____ SYSTEM PROVIDES _____ FOR THE BODY AND IS MADE UP OF SEVERAL PARTS.

 Answer: musculo-skeletal, support

75A

It is very common to hear people complain of back trouble. This is because the back seems to be the most frequent place for a health problem relating to the musculo-skeletal system to occur. Therefore, most of the material in this section will deal with the back.

The back is comprised of the bony spinal column and the muscles and ligaments which support and move the spine. The bones of the spine are called vertebrae. The neck is the most flexible section of the spine while the lower back carries the weight.

FILL IN THE BLANKS

THE MOST FLEXIBLE PART OF THE SPINE IS THE _____ WHILE THE WEIGHT OF THE BODY IS CARRIED BY THE _____.

 Answer: neck, lower back

76A

There are 24 blocks of spongy bone (vertebrae) that support the weight of the body. Each of these blocks has winglike projections that surround and protect the spinal cord and nerves. Between the vertebrae are joints that allow flexible movements. There are also cushions called discs located in the joints between the vertebrae. The discs have a jellylike center located in a crisscross network of tough ligaments and act as shock absorbers for the vertebrae (see Figure 8A). Strong, elastic ligaments hold the bones, joints, and discs together by binding the winglike projections to the vertebrae and binding the bones and discs together. These connections keep the spinal column stable. The back muscles surround the bones in the back and are attached to them. Active movements of the body trunk are made possible by these muscles.

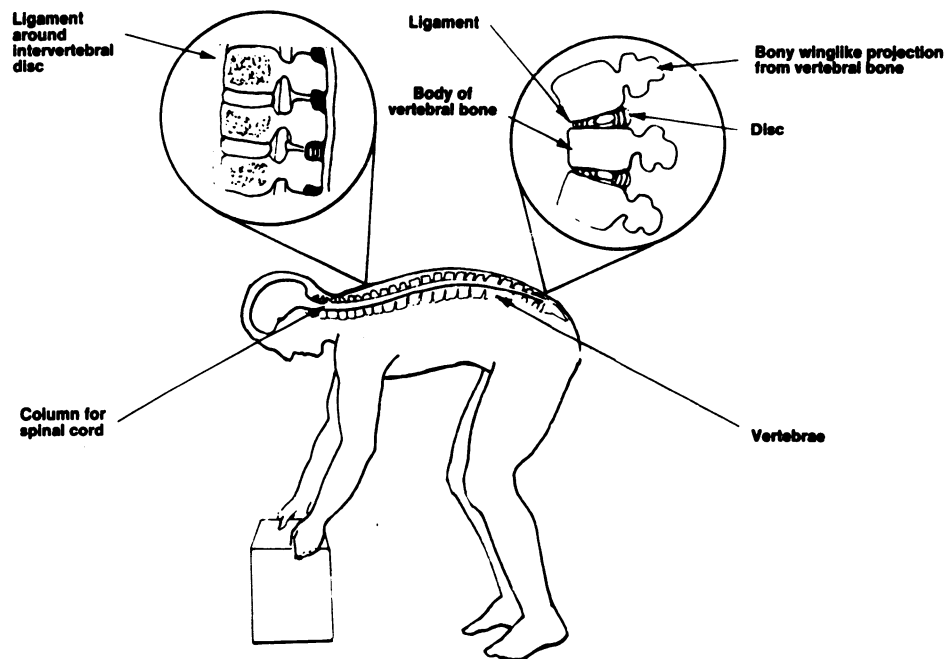


FIGURE 8A. MOVEMENT OF THE SPINE

FILL IN THE BLANK

THE _____ LOCATED BETWEEN THE VERTEBRAE ACT AS SHOCK ABSORBERS.

Answer: discs

77A

The discs are often blamed for many back problems. Although disc injuries do cause some back trouble, many disc problems come simply from growing old. Ligaments around the disc begin to dry out and become less elastic beginning at ages 30 to 40. Once dried out, a person can easily snap or break a ligament by suddenly rotating or bending the spine. If the ligament surrounding the disc has been torn, a ruptured disc can occur and cause pain by pressing on the nerves which enter and leave the spinal cord.

FILL IN THE BLANKS

BY SUDDENLY ROTATING OR BENDING THE SPINE, AN INDIVIDUAL CAN DAMAGE A _____ CAUSING A BACK PROBLEM. SUCH AN INJURY IS MORE LIKELY TO OCCUR, HOWEVER, BEGINNING AT AGES _____.

 Answer: ligament; 30-40

78A

A victim of a back strain has suffered injuries to the joints and ligaments. Because only bones show up on X-ray films, it is often difficult to determine exactly what has been injured. Applying too much force to the ligaments of the spine can cause some of the ligament fibers to tear. This condition causes severe back pain, stiffness, and cramping of the muscles. Although the ligament will heal, a scar will form that is weaker than the original ligament. Repeated back strains will cause the ligaments to become loose, which means that they can be injured more easily.

FILL IN THE BLANKS

BACK STRAINS ARE THE RESULT OF INJURIES TO THE _____ AND _____.

 Answer: joints, ligaments

79A

An injured joint may have a buildup of new bone around its edges. If an X-ray shows joint injury and bony edges around the joint, this disease is called degenerative arthritis or osteoarthritis. Other joints in the spine must take the load that a damaged joint is no longer capable of handling. This additional load may put stress on the other spinal joints and ligaments and lead to further strains.

Other parts of the muscular and skeletal system are constructed similar to the back. That is, they consist of bones, joints, cartilage cushions between joints, ligaments, and tendons. However, they too can be injured in industrial work. Natural body position allows each joint of the body to do the best work. For example, both the hand and the fingers are strongest and most comfortable when extended in a straight line from the arm. The shoulder is strongest and most comfortable when the arms are close to the body. The legs are most comfortable in either of two positions: when the knees are bent at a right angle, or when they are straight. Muscles, ligaments, and joints will become fatigued and may be damaged when performing heavy work or the same work over and over in an unnatural position.

Injury to the tendons can be caused by repetitive use of any part of the body in an unnatural position. For example, repetitive use of the hand causes it to become swollen and sore. This condition is called tendonitis. Injuries resulting from unnatural posture can be prevented by using properly designed equipment. Generally speaking, the most comfortable position for performing a task is usually the right position for the anatomy of the body. Workers, in fact, know which position is most comfortable for them when performing a specific task. For this reason, designers of industrial equipment should consult workers in order to prevent unnecessary fatigue and injury from unnatural work positions. This can be extremely important in the mining industry, especially when working in low seams and using poorly designed equipment.

FILL IN THE BLANK

REPETITIVE USE OF A PART OF THE BODY IN AN UNNATURAL POSITION CAUSES INJURY TO THE _____.

Answer: tendons

REVIEW

LET'S REVIEW THE MATERIAL COVERED CONCERNING THE NERVOUS AND MUSCULO-SKELETAL SYSTEM. MATCH THE PART OF THE NERVOUS SYSTEM ON THE LEFT WITH ITS FUNCTION ON THE RIGHT BY PLACING THE APPROPRIATE LETTER ON THE LINE PROVIDED.

- | | |
|--|---|
| _____ 1. CENTRAL NERVOUS SYSTEM | A. PART OF THE AUTONOMIC NERVOUS SYSTEM THAT STIMULATES DIGESTION, EMPTIES THE BLADDER, AND CAUSES MUCUS SECRETION. |
| _____ 2. CRANIAL NERVES | B. NERVE BUNDLES LEAVING THE SPINAL CORD. |
| _____ 3. SPINAL CORD | C. NERVES THAT OPERATE INDEPENDENTLY OF THE CONSCIOUS MIND TO CARRY OUT LIFE-SUPPORTING FUNCTIONS. |
| _____ 4. PERIPHERAL NERVOUS SYSTEM | D. THE MAIN CONTROL CENTER COMPOSED OF THE BRAIN AND SPINAL CORD. |
| _____ 5. PLEXUSES | E. PERIPHERAL NERVES THAT BRING MESSAGES BACK TO THE CENTRAL NERVOUS SYSTEM. |
| _____ 6. MOTOR NERVES | F. 12 PAIRS OF NERVES THAT COME FROM THE BRAIN. |
| _____ 7. SENSORY NERVES | G. PERIPHERAL NERVES THAT CARRY MESSAGES FROM THE CENTRAL NERVOUS SYSTEM. |
| _____ 8. AUTONOMIC NERVOUS SYSTEM | H. 31 PAIRS OF NERVES THAT EXTEND TO THE LUNGS, ORGANS, MUSCLES, AND SKIN. |
| _____ 9. SYMPATHETIC NERVOUS SYSTEM | I. PART OF THE AUTONOMIC NERVOUS SYSTEM THAT RESPONDS TO STRESS. |
| _____ 10. PARASYMPATHETIC NERVOUS SYSTEM | J. NERVES THAT LEAVE AND REENTER THE CENTRAL NERVOUS SYSTEM IN ALL PARTS OF THE BODY. |
| 11. THE _____ GIVE THE BODY STRUCTURE. | |
| 12. THE _____ HOLD THE BONES TOGETHER. | |

13. THE _____ FIRMLY HOLD THE MUSCLES TO THE BONES.
14. THE _____ IS THE MOST MOVABLE PART OF THE SPINE AND THE _____ CARRIES THE WEIGHT.
15. TENDONS CAN BE DAMAGED AS A RESULT OF _____ USE OF ANY PART OF THE BODY, AND THIS CAN BE PREVENTED BY USING _____ EQUIPMENT.

- Answers:
- | | |
|------|-----------------------------------|
| 1. D | 9. I |
| 2. F | 10. A |
| 3. H | 11. bones |
| 4. J | 12. ligaments |
| 5. B | 13. tendons |
| 6. G | 14. neck, lower back |
| 7. E | 15. repetitive, properly designed |
| 8. C | |

If the correct answers were not clear, review before moving ahead. The final part of Section A deals with the parts of the body that enable persons to use, if maintained, their senses of touch, hearing, and sight.

Skin

The skin, covering about 20 square feet, is the largest organ of the body. It provides initial protection for the body and is the organ that is most likely to be injured in the industrial environment. Of all reported occupational diseases about two-thirds, or 65 percent, affect the skin.

The skin is the principal barrier providing the body's main defense attack. As such, the skin is tough, flexible, resistant, relatively water-proof, and beautiful. The skin can thus successfully defend against many attacks, but not all of them.

FILL IN THE BLANKS

THE _____ IS THE LARGEST ORGAN OF THE BODY, AND IT ACCOUNTS FOR _____ PERCENT OF ALL OCCUPATIONAL DISEASES.

Answer: skin, 65

The dermis and epidermis are the two layers that make up the skin. The outer layer, the epidermis, consists of a densely packed layer of cells, which constantly divide and are replaced by young cells. As a cell gets older it moves toward the outer surface of the skin. During this process, the cells make a tough protein, called keratin, which is resistant to dust, germs, and many chemicals. Keratin and layers of dead epidermis cells make up the outermost layer of the skin. This epidermal outer layer produces the skin color that is important in protecting the skin against damage from sunlight. The epidermis also contains sweat glands, hair follicles, and blood vessels, all of which are important in regulating body temperature. In addition, the epidermis contains glands that make a substance that is somewhat like ear wax forming a protective oily film over the outer layers of the epidermis. The epidermis then is protected from chemical and physical injury by three things: the outer layer of dead cells, the tough keratin, and the oily coating.

The dermis, or inner layer of skin, is made up of fat and connective tissue. It holds the epidermis to the body and provides insulation for the body. The dermis is known as the true skin. When injured, it can form scar tissue and repair itself. It also contains nerves that warn the body of certain changes. A microscopic cross-section of the skin is shown in Figure 9A.

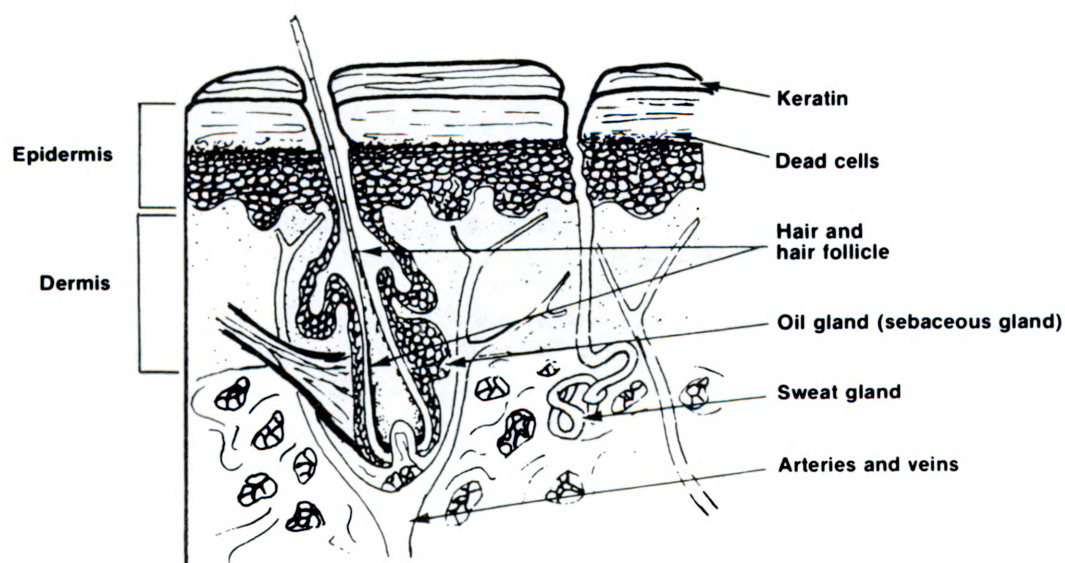


FIGURE 9A. CROSS-SECTION OF THE SKIN

FILL IN THE BLANKS

THE TWO LAYERS OF SKIN ARE CALLED THE _____ OR OUTER LAYER AND THE _____ OR INNER LAYER. PROTECTIVE DEVICES OF THE OUTER LAYER OF SKIN INCLUDE DEAD CELLS, _____, AND AN OILY COATING, WHEREAS THE INNER LAYER CONTAINS NERVES FOR WARNING AND IS ABLE TO REPAIR ITSELF BY FORMING _____.

 Answer: epidermis, dermis; keratin, scar tissue

86A

In addition to their useful purposes, both the hair follicles and sweat glands provide a way for substances to enter the body. This characteristic of the skin can cause problems for a person. In fact, according to the National Safety Council, about 700,000 workers have some type of skin disease, and the financial loss from occupational skin disease in the United States exceeds \$100 million each year. This loss occurs due to lower productivity, poor morale, turnover, and medical costs resulting from the disease.

87A

A big industrial health problem, therefore, does exist in spite of the protective mechanisms of the skin. Most of these problems are the result of irritants. They affect the skin of people in different ways, depending on such things as type of skin, age, sex, season of the year, history of previous skin disease, allergies, and personal hygiene. As a result of these attacks, irritation to the skin develops resulting from exposure to irritants in the work environment. This condition is called industrial dermatitis. Symptoms of dermatitis range from a slight reddening of the skin and mild itching to open sores and swelling.

FILL IN THE BLANKS

EXPOSURE OF THE SKIN TO CERTAIN _____ IN THE WORK ENVIRONMENT CAN CAUSE INDUSTRIAL _____.

 Answer: irritants, dermatitis

Common causes of dermatitis are: chemical compounds and oils; mechanical agents that cause friction and pressure; physical agents such as heat, cold, light, and radiation; plant poisons; and biological agents including bacteria, fungi, and parasites. These causes can result in dermatitis in various ways. A primary irritant from these categories will cause dermatitis at the site of contact on anyone's skin, but the degree of irritation may vary with the amount of the agent and the length of exposure. Examples of primary irritants are heat, friction, acids, or alkalis (compounds able to neutralize an acid). There are, in fact, 2000 chemicals classified as primary irritants, and there are several hundred more added to this list each year.

Dermatitis caused by a primary irritant is termed contact dermatitis because it appears at the place the skin has been in direct contact with the irritant but does not spread. It usually disappears when an individual avoids contact with the irritant but will reappear again upon contact. For example, without proper protection, all workers who handle the same amounts of an irritating chemical are likely to develop contact dermatitis on the hands because chemical agents produce the highest percentage of all occupational dermatitis.

FILL IN THE BLANKS

A _____ IRRITANT CAUSES DERMATITIS ON ANYONE'S SKIN UPON CONTACT, AND AS A RESULT IT IS TERMED _____.

 Answer: primary, contact dermatitis

Several chemical and biological agents are called sensitizers. A sensitizer may not cause an initial irritation upon contact; however, after repeated or frequent contact, some individuals may develop an allergic type reaction to a certain material. This is called allergic sensitization dermatitis. An example of an allergic sensitizer is poison ivy because everybody who comes in contact with this plant does not develop an irritation.

A reaction to an allergic sensitizer may also occur when the skin comes in contact with substances similar to the original producer of the reaction. These allergic reactions to the sensitizer can recur upon contact even years after the initial reaction. There are also some sensitizers that only affect the skin in the presence of light (usually ultraviolet light). These are termed photosensitizers.

FILL IN THE BLANKS

POISON IVY IS AN EXAMPLE OF AN _____ BECAUSE IT MAY NOT CAUSE AN INITIAL IRRITATION UPON CONTACT.

 Answer: allergic sensitizer

Other skin irritants can occur from mechanical causes such as handling fiberglass, where particles from the material stick in the skin causing an itch. However, it is probably the individual's scratching and rubbing that cause the actual dermatitis. Also, irritation can result from physical problems like blockage of hair follicles or sweat and oil ducts. This is often caused by industrial oils. In fact, it is believed that cutting oils are the largest single source of industrial dermatitis. This is generally referred to as oil dermatitis and is commonly known as acne or blackheads.

No matter what the cause, the best way to control dermatitis is to prevent any contact with irritants. If there is no contact, there can be no dermatitis. This, however, is more easily said than done, especially in an industrial environment.

FILL IN THE BLANKS

CUTTING OILS CAN CAUSE _____ DERMATITIS, AND THE BEST WAY TO PREVENT THIS OR ANY TYPE OF DERMATITIS IS TO AVOID _____ WITH THE IRRITANT.

 Answer: oil, skin contact

The Ear

In addition to the problems caused by skin irritants, it has been known for more than 100 years that workers employed in noisy jobs develop a greater than average degree of hearing loss. Noise is simply defined as unwanted sound, created by vibrations transmitted in the air that are conducted through solids, liquids, or gases and received by the human ear. The louder a noise becomes, the higher is its intensity. Frequency, on the other hand, is the highness or lowness of pitch, and high frequency noises seem to be more

damaging than low frequency noises. Also, the longer a person is exposed to noise, the greater the hearing damage.

FILL IN THE BLANKS

UNWANTED SOUND IS CALLED _____ AND _____ FREQUENCY SOUNDS CAUSE MORE HEARING DAMAGE.

Answer: noise, high

The ear is divided into three parts: the external ear, the middle ear, and the inner ear. Figure 10A shows the various parts of the ear.

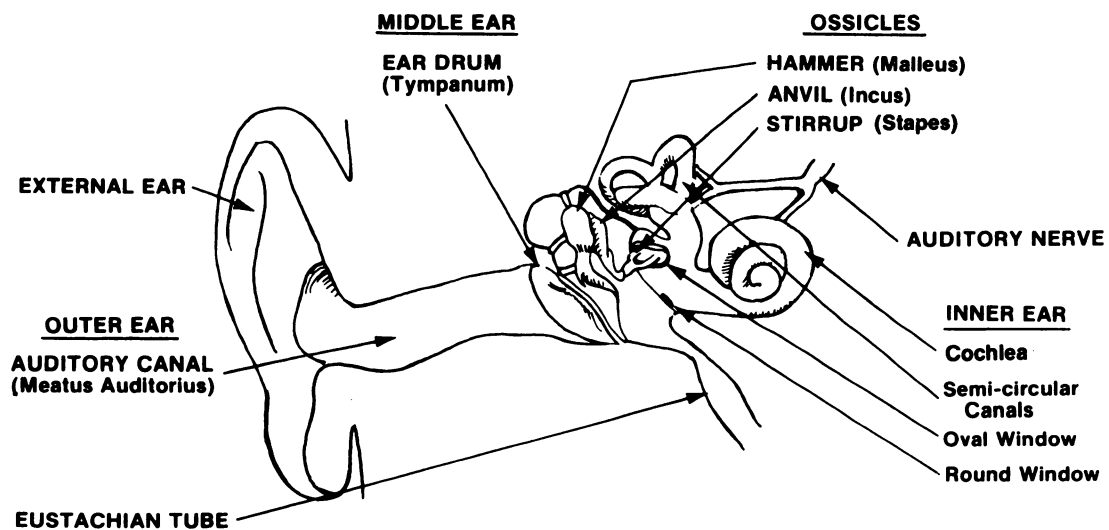


FIGURE 10A. STRUCTURE OF THE EAR

The external ear is that part of the ear that is attached to the head and is visible to others. Its main job is to capture and transport sound through the auditory canal to the eardrum (tympanic membrane). The eardrum is very thin, like the head on a drum, and when it is hit with sound vibrations, it acts like a drum being hit and vibrates back and forth. It is here

that the first step in the translation of sound waves into nervous impulses takes place and the hearing process begins.

FILL IN THE BLANKS

SOUND IS CAPTURED BY THE _____ EAR AND IS TRANSPORTED THROUGH THE _____ WHERE IT CAUSES THE _____ TO VIBRATE.

Answer: external, auditory canal, eardrum

The movement of sound waves passes next to the middle ear which is filled with air and contains a chain of three very small bones (or ossicles). These bones are called the hammer (malleus), anvil (incus), and stirrup (stapes) because they look like these objects in shape. The vibration of sound waves causes these bones to move and hit one another. This action, in turn, conducts the sound from the eardrum to another membrane called the oval window. One of these three bones, the hammer, rests against the eardrum. At the other end of the middle ear, the stirrup is connected to the inner ear. (Refer again to Figure 10A.)

FILL IN THE BLANKS

A CHAIN OF THREE BONES, THE _____, _____, AND _____ TRANSFER SOUND FROM THE MIDDLE EAR TO THE INNER EAR.

Answer: hammer, anvil, stirrup

The oval window connects the middle ear to the inner ear. The inner ear has two main parts consisting of a series of cavities and spiraled tubes. Referring again to Figure 10A, the three semicircular canals have the job of maintaining body balance. The other part of the inner ear that is shaped like a snail shell and is lined with very fine hair cells and filled with fluid is called the cochlea. Movement of the oval window causes the fluid in the cochlea to vibrate, stimulating the hairs. A nerve impulse results that in turn stimulates the auditory nerve sending the sound message to the brain.

FILL IN THE BLANKS

THE SNAIL SHELL SHAPED PART OF THE INNER EAR IS CALLED THE _____ AND CONTAINS _____ AND _____ WHICH STIMULATE THE AUDITORY NERVE.

 Answer: cochlea, fluid, hairs

The ear, like other organs of the body, also has several natural defenses against injury. Hair and ear wax located in the auditory canal help trap and keep out small objects. The auditory canal is also bent, thus reducing the chance of objects entering and damaging the eardrum. Finally, the eardrum and middle ear have the ability to reduce the intensity of noise transmitted to the inner ear. The functioning parts of the inner ear are very delicate and can be damaged easily, resulting in deafness. For this reason, reduction in sound intensity is necessary.

CIRCLE THE CORRECT ANSWER

AS A MEANS OF NATURAL DEFENSE, THE EAR

- A. PRODUCES WAX AND HAS HAIR
- B. HAS A BENT AUDITORY CANAL
- C. TRANSMITS LOUD NOISE TO THE INNER EAR
- D. BOTH A AND B
- E. NONE OF THE ABOVE

 Answer: D

The ear also can equalize pressure so that the eardrum can vibrate properly. Since the auditory canal and middle ear are filled with air, different air pressures tend to have an effect on the eardrum that separates these two parts of the ear. In order for the ear to adjust to pressure changes, preventing the eardrum from rupture, the middle ear has a safety valve. This safety valve is called the eustachian tube, and it connects the middle ear and the back of the throat. For instance, many individuals feel

their safety valve open or their ears pop while flying in an airplane or while driving up or down a mountain. If this does not happen automatically, some people try swallowing, yawning, or chewing in order to open the safety valve.

FILL IN THE BLANKS

ANOTHER DEFENSE MECHANISM OF THE EAR IS ITS ABILITY TO ADJUST TO PRESSURE CHANGE WITH A SAFETY VALVE CALLED THE _____.

Answer: eustachian tube

Noise can startle or annoy a person, interfere with communication, and produce various physical effects such as loss of hearing, pain, nausea, and even lack of muscle control. Loss of hearing can be either a temporary or permanent injury. Temporary hearing loss occurs from exposure to loud noises for a few hours with normal hearing eventually returning. Permanent hearing loss, however, occurs as a result of disease, physical injury, the aging process (presbycusis), or exposure to loud noise for extended periods of time.

FILL IN THE BLANKS

HEARING LOSS CAN BE EITHER _____ OR _____ AND WHEN IT OCCURS AS THE RESULT OF OLD AGE, IT IS CALLED _____.

Answer: temporary, permanent, presbycusis

There are a number of different factors that have an influence on the effects of noise exposure. These differences include: an individual's susceptibility; the intensity or strength of sound; the frequency of the sound; total time of exposure; length of employment associated with a noisy environment; and other factors, such as whether the exposure to noise was continuous or varied. However, every noise problem has three basic parts: a source, a path along which the sound travels, and a receiver, like the human ear. Noise does, in fact, present a major industrial health problem, especially where workers are exposed to noise over many years of work.

FILL IN THE BLANK

FACTORS SUCH AS THE AMOUNT OF TIME WORKERS SPEND EXPOSED TO NOISE AND WHETHER OR NOT THE NOISE WAS CONSTANT OR VARIED HAVE AN _____ ON THE EFFECTS OF NOISE EXPOSURE ON THE INDIVIDUAL.

Answer: influence

100A

The Eye

Of all the major organs that sustain industrial injuries, the eye is one of the most likely to be hurt. The eye itself is housed in cushioning fatty tissue that provides needed insulation for the eye. For additional protection, the eyebrow area above the eye and the cheek ridges below the eye both project beyond the eye itself. The eyelid and front of the eyeball are covered with a mucous membrane called the conjunctiva, and the cornea provides a transparent covering over the outer portion of the eye.

The eye has a lens system similar to that of a camera. This system focuses on an image, and special sensory cells in the retina change a visual image into an electrical message that is carried by the optic nerve to the brain. The brain receives the message and interprets it. This process is called seeing. Figure 11A illustrates some of the major components of the eye.

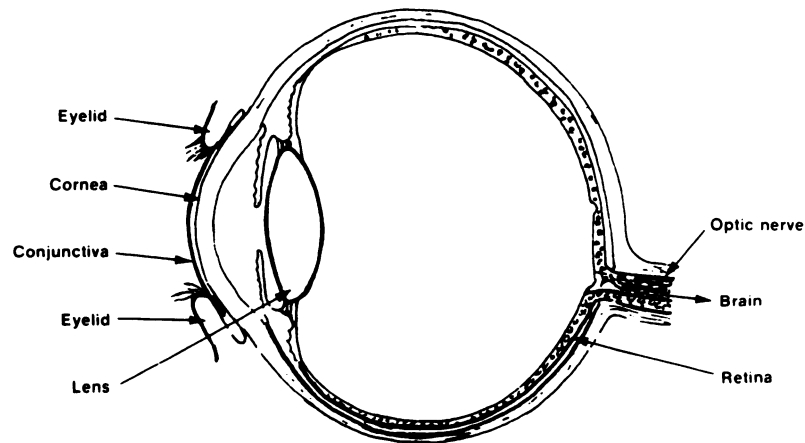


FIGURE 11A. ILLUSTRATION OF THE EYE

FILL IN THE BLANKS

THE EYE FUNCTIONS LIKE A CAMERA AND A VISUAL IMAGE IS CHANGED INTO AN ELECTRICAL MESSAGE BY THE _____ AND THE _____ TRANSMITS THIS MESSAGE TO THE BRAIN SO THAT AN INDIVIDUAL CAN SEE.

 Answer: retina, optic nerve

The cornea and lens are not furnished by a large supply of blood vessels and, as a result, these parts of the eye do not heal rapidly if hurt. Also, the retina or photographic film of the eye is made of mostly nerves, and nerves cannot repair themselves if damaged. In spite of these problems, the eye does have some natural defenses against occupational disease and injury. For example, the bony ridges of the skull around the eyebrow protect the eye from injury due to impact. The cushioning and insulating layers of conjunctiva and muscle around the eye also tend to absorb impact. In addition, the fact that the eyeball can be dislodged and come out is actually a defense against injury. The eye also has a unique windshield wiper and washer combination similar to that of a car. The blink prevents objects from getting in the eye, and tears have the job of washing objects off the surface of the eye. These defenses, however, are no match for some eye hazards that result from working in an industrial setting.

CIRCLE THE CORRECT ANSWER

WHICH OF THE FOLLOWING ARE NATURAL DEFENSES OF THE EYE?

- A. BLINKING
- B. TEAR RESPONSE
- C. THE EYEBALLS' ABILITY TO COME OUT
- D. ALL THE ABOVE

 Answer: D

Blows from blunt objects produce pressure on the eyeball and can cause injury; an actual rupture of the eye might occur as the result of an extremely hard blow. Bruises (contusions) on the eye can cause an irreversible injury because blood released during hemorrhaging can actually be harmful to the tissues of the eye. Sharp objects, on the other hand, can cause a tear or cut of the cornea, eyelid, or conjunctiva.

Foreign objects, however, produce the most common form of physical injury to the eye. Particles traveling at low speed and hitting the eye are likely to lodge in or on the cornea or conjunctiva, whereas those traveling at high speed are likely to lodge within the eye. Generally speaking, foreign bodies that affect the exposed part of the eye are not too serious because they are located away from the apparatus of seeing. The presence of such foreign bodies can result in redness and discomfort, but usually not vision damage. If the person with a foreign body affecting the conjunctiva rubs the eye, the foreign body may be transferred to the cornea where it could become imbedded. For this reason, a medical checkup is advisable, even for something that may at the outset seem minor, like a speck in the eye. Figure 12A tells you what you can do if a foreign object gets in your eye.

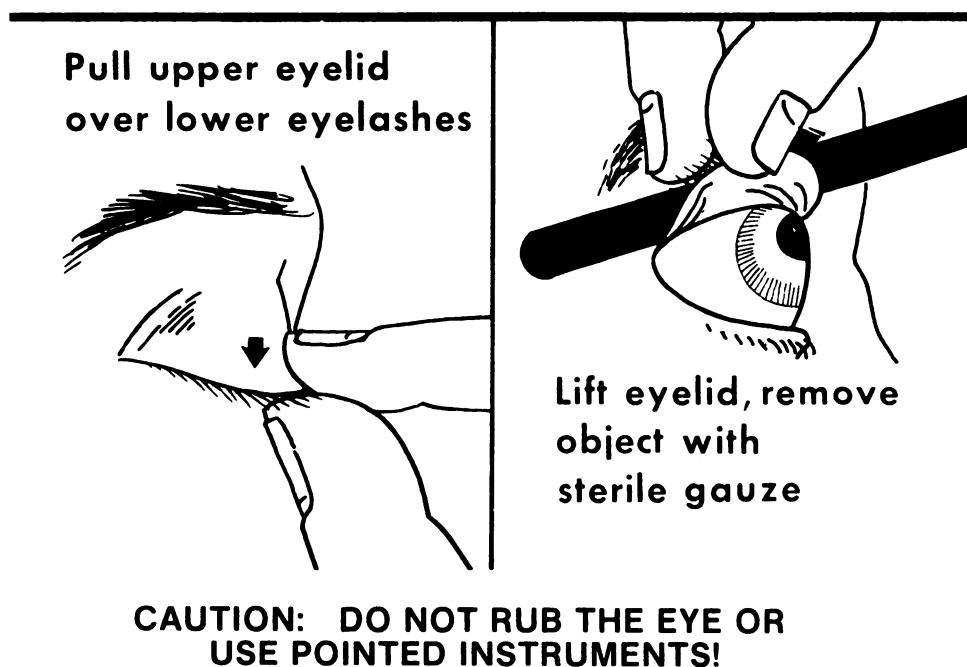


FIGURE 12A. FOREIGN OBJECTS IN THE EYE

FILL IN THE BLANKS

THE MOST COMMON PHYSICAL INJURY TO THE EYE OCCURS AS THE RESULT OF _____.

Answer: foreign objects

104A

As mentioned, foreign bodies can lodge on or in the eye. Foreign bodies found in the industrial work environment, however, are most likely to affect the cornea or outer part of the eye. When this happens, there can be different effects on the eye. Pain can develop because the cornea has many nerves. A foreign particle can stimulate these nerves causing an uncomfortable sensation. Infection can also occur from bacteria or fungi being transferred to the eye from the fingers. People run this risk when something gets in their eyes, and then they rub the eye. Most importantly, an individual's vision can be obscured if particles lodging on the eye cause scarring. Tissue of the cornea will heal; however, scars can do nothing but harm a person's sight.

CIRCLE THE CORRECT ANSWER

OBJECTS ON THE EYE CAN CAUSE

- A. PAIN
- B. INFECTION
- C. SCARRING
- D. ALL THE ABOVE

Answer: D

105A

If a foreign object, by chance, penetrates the eye, what is the effect? Infection can occur, but it seems that the speed of an object entering the eye is the determining factor concerning infection. For example, metal objects that enter the eye at high speed create heat upon penetration, and this heat, in fact, sterilizes the wound, helping to prevent infection. Slower moving wood particles do not heat up, and if they get into the eye, dangerous

105A

infection can occur resulting in vision reduction. In addition to speed, an object's angle at the point of entry determines the amount of damage to parts of the eye such as the cornea, lens, or retina.

FILL IN THE BLANK

THE DETERMINING FACTOR CONCERNING EYE INFECTION SEEMS TO BE THE _____ OF A FOREIGN OBJECT ENTERING THE EYE.

Answer: speed

106A

Lens damage is serious because the lens does not have a good blood supply; consequently, it is slow to heal. Damage to the eye from flying objects causes cell damage as well as hemorrhaging of small blood vessels. In fact, the iron normally found in the blood is actually harmful to the eye.

Pure copper particles are even more dangerous. If these particles lodge in the eye, the eye is almost certain to be destroyed as a result of copper poisoning.

FILL IN THE BLANKS

SERIOUS DAMAGE CAN OCCUR TO THE _____ OF THE EYE BECAUSE IT IS _____ TO HEAL.

Answer: lens, slow

107A

Pain, however, cannot be counted on to warn an individual that a foreign particle has penetrated the eye. In fact, there have been cases where workers barely remember getting something in their eye, think nothing of it due to the lack of pain, and eventually lose sight in the eye as a result of the damage done by the penetrating object.

FILL IN THE BLANK

AN INDIVIDUAL CANNOT COUNT ON _____ TO BE A WARNING OF EYE INJURY.

Answer: pain

In many industrial work environments, other more serious eye injuries occur as a result of burns. These burns to the eye result from such things as chemicals, specifically acids or alkalis, heat, or radiation. Chemical burns usually produce a scar on the cornea. It is interesting to note that alkalis or lye solutions cause more severe injuries than acids. In fact, with an alkali burn, the eye may not appear to be hurt too seriously on the first day of the injury; however, the condition of the eye will continue to get worse over a period of days. An acid burn, on the other hand, has an initial appearance that gives a good immediate indication of the total eye damage. The difference in reaction to these two chemical substances is due to the fact that acids tend to settle on the protein barrier of the eye preventing further penetration into the eye. Alkalis, however, continue to soak through eye tissue as long as they remain there.

Heat from such burns can destroy eye and eyelid tissue in the same way it destroys other body tissue. However, eye tissue may not recover as quickly from a burn as skin and muscle tissue. Since involuntary closing of the eye is almost certain response to excessive heat, the lids are more likely to be involved in burns than the eye itself.

Optical radiation commonly found in industry can also harm the eyes:

- Welding operations create exposure to ultraviolet light. A welder is too close to the arc to be able to look at it without a proper eye-shield and therefore rarely suffers such injury. Exposure in this case is more likely to injure the cornea of a welder's helper or other bystander. The harmful effects of ultraviolet (UV) radiation on the cornea add up, and the painful result may be delayed.
- UV radiation penetrates the cornea of the eye only at high concentrations because the surface of the cornea acts to filter it out. Damage to the retina, therefore, would be unlikely if the only source of UV radiation was a welding flash.
- Unlike ultraviolet, infrared radiation passes easily through the cornea. The energy of the radiation is then absorbed by the retina. Eye damage due to infrared radiation is less common today than in the past. However, cataracts (clouding of the lens) still result as an occupational disability among some glass blowers.

FILL IN THE BLANKS

SERIOUS INJURIES TO THE EYE FROM BURNS RESULT FROM _____ AND _____
 AS WELL AS _____ AND _____ RADIATION.

 Answer: chemicals, heat, ultraviolet, infrared

In concluding the first section of this programmed instruction course, let's review and determine what has been learned about the eyes, ears, and the skin.

1. SKIN IRRITATION CAUSED BY DIRECT CONTACT WITH CHEMICALS
 - A. ALWAYS APPEARS AT THE POINT OF CONTACT
 - B. GOES AWAY WHEN CONTACT IS ENDED
 - C. DOES NOT SPREAD TO OTHER PARTS OF THE BODY
 - D. ALL THE ABOVE
 - E. NONE OF THE ABOVE
2. TYPE OF SKIN, AGE, SEX, ALLERGIES, AND PERSONAL HYGIENE OR CLEANLINESS DETERMINE
 - A. A HISTORY OF SKIN DISEASE
 - B. HOW OFTEN A SKIN DISEASE WILL OCCUR
 - C. THE EFFECT OF A SKIN IRRITANT
 - D. NONE OF THE ABOVE
3. THE MOST COMMON CAUSES OF DERMATITIS RESULT FROM _____, PLANT POISONS, AND _____, _____, AND _____ AGENTS.
4. THE HIGHEST PERCENT OF ALL OCCUPATIONAL DERMATITIS IS CAUSED BY _____.

5. THE LARGEST SOURCE OF INDUSTRIAL DERMATITIS OCCURS AMONG INDIVIDUALS WORKING WITH
 - A. PLANTS
 - B. CUTTING OIL
 - C. HEAT
 - D. BIOLOGICAL AGENTS
6. THE HEARING PROCESS BEGINS WHEN SOUND
 - A. IS CAPTURED
 - B. STARTLES AN INDIVIDUAL
 - C. VIBRATES THE EARDRUM BACK AND FORTH
 - D. NONE OF THE ABOVE
7. THE TRANSFER OF SOUND TO THE INNER EAR OCCURS AS A RESULT OF
 - A. THE ACTION OF THE MIDDLE EAR
 - B. VIBRATION OF THE HAMMER, ANVIL, AND STIRRUP
 - C. A CHAIN OF THREE SMALL BONES HITTING ONE ANOTHER
 - D. BOTH B AND C
 - E. ALL THE ABOVE
8. BALANCE IS MAINTAINED BY THE _____ AND THE _____ STARTS A NERVE IMPULSE WHICH IS SENT TO THE BRAIN AS A SOUND MESSAGE.
9. WHICH ONE OF THE EAR'S NATURAL DEFENSES HAS THE JOB OF EQUALIZING PRESSURE CAUSING THE EAR TO POP?
 - A. HAIR AND WAX BUILDUP
 - B. A STRAIGHT AUDITORY CANAL
 - C. EUSTACHIAN TUBE
 - D. NONE OF THE ABOVE

10. NOISE PROBLEMS HAVE SEVERAL BASIC PARTS CONSISTING OF
- A. A SOURCE AND RECEIVER
 - B. INDIVIDUAL SUSCEPTIBILITY
 - C. PATH FOR THE SOUND
 - D. BOTH A AND C
 - E. ALL OF THE ABOVE
11. A MUCOUS MEMBRANE COVERING THE EYE IS CALLED THE _____ AND THE TRANSPARENT COVERING OVER THE OUTER PORTION OF THE EYE IS THE _____.
12. WHICH OF THE FOLLOWING ARE NOT NATURAL DEFENSES OF THE EYE
- A. A LARGE SUPPLY OF BLOOD
 - B. BONY RIDGES OF THE EYEBROW
 - C. THE ABILITY OF THE EYEBALL TO BE DISLODGED
 - D. BLINK AND TEAR SYSTEM
 - E. ALL OF THE ABOVE
13. FOREIGN BODIES RESULTING FROM WORK ACTIVITIES IN THE INDUSTRIAL ENVIRONMENT MOST LIKELY WILL AFFECT THE _____ OF THE EYE CAUSING POSSIBLE PAIN, INFECTION, OR SCARRING.
14. MINERS IN WHAT INDUSTRY RUN THE HIGHEST RISK OF EYE DESTRUCTION IF THE PRODUCT OF THAT INDUSTRY WOULD HAPPEN TO LODGE IN THE EYE?
- A. COAL
 - B. TIMBER
 - C. COPPER
 - D. URANIUM
15. MINERS USING WELDING EQUIPMENT SHOULD AVOID EXPOSURE TO
- A. EXPOSED LIGHT
 - B. INFRARED LIGHT
 - C. SPECTRAMATIC LIGHT
 - D. ULTRAVIOLET LIGHT
-

- Answers:
1. D
 2. C
 3. chemicals, physical, mechanical, biological
 4. chemicals
 5. B
 6. C
 7. E
 8. semicircular canals, cochlea
 9. C
 10. E
 11. conjunctiva, cornea
 12. A
 13. cornea
 14. C
 15. D

If the correct answers were not clear, review before moving ahead to Section B. This concludes the first section of the course, "Industrial Hygiene and the Human Body." Next, let's examine the Recognition of Health Hazards.

INDUSTRIAL HYGIENE
FOR THE MINING INDUSTRY

SECTION B

"RECOGNITION OF HEALTH HAZARDS"

This frame begins Section B of the Industrial Hygiene course. It is entitled "Recognition of Health Hazards."

This section will concentrate on toxicology, routes of entry, dose-response relationships, threshold limit values, and the recognition of various environmental stress factors found in the workplace that directly affect the human body. Specifically, the objective will be to recognize the effects of toxic substances such as liquids, vapors, gases, mists, fumes, and dust, as well as environmental factors such as radiation, noise, vibration, and temperature and pressure extremes. In addition, time will also be spent on recognizing both mental and physical ergonomic stresses.

Again, as in Section A, questions will be asked throughout this section. Remember to answer the questions before checking the correct answer immediately following the question.

TRUE OR FALSE

SECTION B IS TO BE COMPLETED IN A DIFFERENT WAY THAN SECTION A. _____

Answer: false

2B

Toxicology

Each year there are hundreds of new chemicals produced. Many are potential hazards. It is for this reason that a knowledge of toxicology is important in an industrial environment. Toxicology is nothing more than the study of the nature and action of poisons. Industrial toxicology is concerned with the effects poisons have on individuals who have been exposed while at work.

FILL IN THE BLANKS

THE STUDY OF THE EFFECTS POISONS HAVE ON INDIVIDUALS IN THE WORKPLACE IS TERMED _____.

Answer: industrial toxicology

There are, however, degrees of safeness and harmfulness for all materials. Any substance can be harmful to an individual if that individual is exposed to just the right amount. Some substances may produce a harmful effect in all individuals. There are even those substances that may only affect certain people and not others (individual differences) due to the rate of an individual's metabolism. Also, other substances may affect only certain parts of the body. This harmful effect on humans is referred to as toxicity. It should be pointed out that the terms toxicity and health hazard are not the same. Toxicity is merely the ability of a material to produce injury or harm whereas a health hazard occurs if it is possible that a certain material in a specific amount will cause an injury under certain conditions.

Toxicity is dependent upon the dose, rate, method, and the location where a toxic substance enters the body. Toxicity is also influenced by an individual's state of health, individual differences, the ability of an individual to resist stress (tolerance), diet, temperature, and age.

FILL IN THE BLANKS

THE ABILITY OF A MATERIAL TO PRODUCE INJURY OR HARM TO AN INDIVIDUAL IS TERMED _____. TOXICITY IS _____ UPON AND IS _____ BY A VARIETY OF FACTORS.

 Answer: toxicity; dependent, influenced

There are, however, three differences when considering toxicology and its effects at home and at the workplace. First, when considering how a substance is taken into the body, the most common way at home is by way of mouth whereas at work it is through inhalation or the respiratory tract. The second difference is that poisoning at work tends to occur over longer periods of time whereas at home, poisoning occurs right away. The final difference is that poisoning at work is generally a result of exposure to a variety or mixture of substances compared with usually a single substance being at fault in the home environment.

Harmful industrial poisoning usually occurs without voluntary action on the part of the individuals poisoned and perhaps without them even being aware that it is happening. At home, on the other hand, persons are usually poisoned accidentally by ingesting a poisonous substance.

FILL IN THE BLANKS

4B

	<u>AT WORK</u>	<u>AT HOME</u>
TYPE OF ENTRY -	_____	MOUTH
TYPE OF POISONING -	CHRONIC	_____
TYPE OF SUBSTANCE -	_____	ONE SUBSTANCE

Answers:

	<u>AT WORK</u>	<u>AT HOME</u>
Type of Entry -	<u>Inhalation</u>	<u>Mouth</u>
Type of Poisoning -	<u>Chronic</u>	<u>Acute</u>
Type of Substance -	<u>Mixture</u>	<u>One Substance</u>

(Once complete, this chart can serve as a ready reference comparing poisonings at work and at home.)

5B

Routes of Entry

In order to do any damage to the human body, these toxic substances have to enter or come in contact with the body. This is accomplished in various ways, usually by one of three routes. These are termed routes of entry, and they occur by way of inhalation, ingestion, or skin contact. Figure 1B shows the various routes of entry.

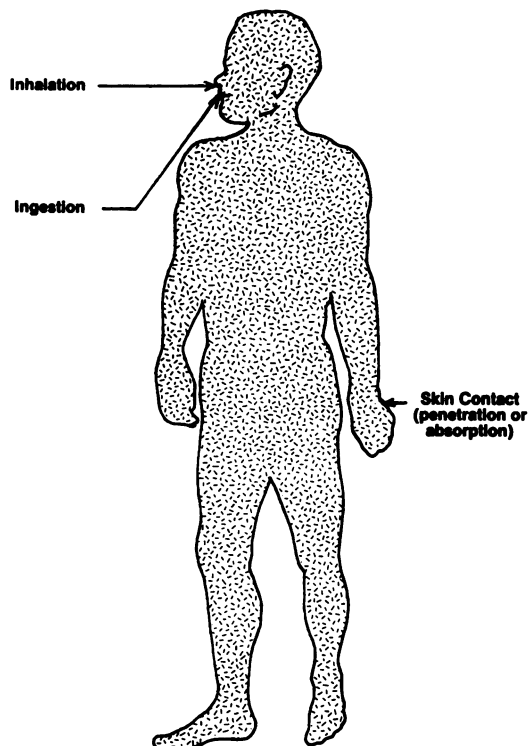


FIGURE 1B. ROUTES OF ENTRY

FILL IN THE BLANKS

THERE ARE _____ MAIN ROUTES OF ENTRY INTO THE BODY: _____,
_____, AND _____.

Answer: three, ingestion, absorption, inhalation

Ingestion or swallowing of toxic substances can occur as a result of eating or smoking with contaminated hands in a contaminated work area. As a result, the toxic substance is swallowed and absorbed in the digestive system and picked up by the blood. This situation is most likely to occur with larger size particles usually over 2 microns in size. However, if there is enough of the contaminant existing so that it can be ingested, the chance of inhaling the toxic material will probably also exist.

FILL IN THE BLANK

EATING WITH DIRTY HANDS CAN RESULT IN _____ OF HARMFUL SUBSTANCES.

Answer: ingestion

Skin absorption occurs when the body comes in contact with a toxic agent. This type of exposure ranks first in the cause of occupational disease, but is not necessarily the most severe. Such an exposure can cause a reaction on the surface of the skin, or the toxic substance may penetrate the skin in a sufficient amount to cause either sensitization to repeated exposures or poisoning to other systems of the body.

CIRCLE THE CORRECT ANSWER

THE ROUTE OR MODE OF ENTRY THAT RANKS FIRST IN OCCURRENCE IN THE INDUSTRIAL WORK ENVIRONMENT IS:

- A. OCCULAR
- B. INGESTION
- C. INHALATION
- D. SKIN ABSORPTION

Answer: D

Inhalation is the route of entry that is of prime importance and concern in the industrial environment due to the speed of toxic substance can enter the lungs, pass into the blood, and reach different parts of the body causing its harmful effects. This situation occurs when small particles, usually less than 5 microns in size, are breathed in. Once inside the body, the toxic substance usually affects the functioning tissues of the lung.

An important difference, however, between inhalation and the other two modes of entry is that in the case of inhalation the toxic substance enters the arterial blood directly, whereas with ingestion and absorption it does not.

CIRCLE THE CORRECT ANSWER

WHICH OF THE FOLLOWING ROUTES OF ENTRY IS OF MOST IMPORTANCE IN THE WORKPLACE?

- A. OCCULAR
- B. INGESTION
- C. INHALATION
- D. ABSORPTION

Answer: C

9B

Remember, a toxic substance can cause either acute or chronic poisoning. Acute poisoning is usually severe, happens suddenly, and is the result of a single dose of a substance that is absorbed rapidly. For example, carbon monoxide produces acute poisoning. Chronic poisoning, on the other hand, occurs over a long period of time in relatively small dosages. An example of a chronic poisoning condition would be coal workers' pneumoconiosis.

FILL IN THE BLANKS

TOXIC POISONING CAN EITHER BE _____ OR _____.

Answer: chronic, acute

10B

The severity of a toxic substance, however, depends on the amount of that substance in the body. This in turn depends on the substance's ability to be dissolved before absorption, or the body's ability to make the substance non-harmful (detoxification), and the rate of elimination (excretion) of the substance from the body.

FILL IN THE BLANK

THE SEVERITY OF A TOXIC SUBSTANCE DEPENDS ON THE _____ OF THE SUBSTANCE IN THE BODY.

 Answer: amount

11B

Dose-Response Relationship

Since the severity of a toxic substance depends on the amount or dose of that substance, a single large dose can produce a response greater than the same dose administered over a longer period of time. The body does respond in some way to any amount of a substance which enters or touches it. However, the type of response will differ depending on the type and amount of the substance. For this reason, anything can be harmful in a large amount, but in small amounts, the same substance can be relatively harmless. Such a statement can be explained and illustrated by what is called a dose-response relationship. (See Figure 2B.)

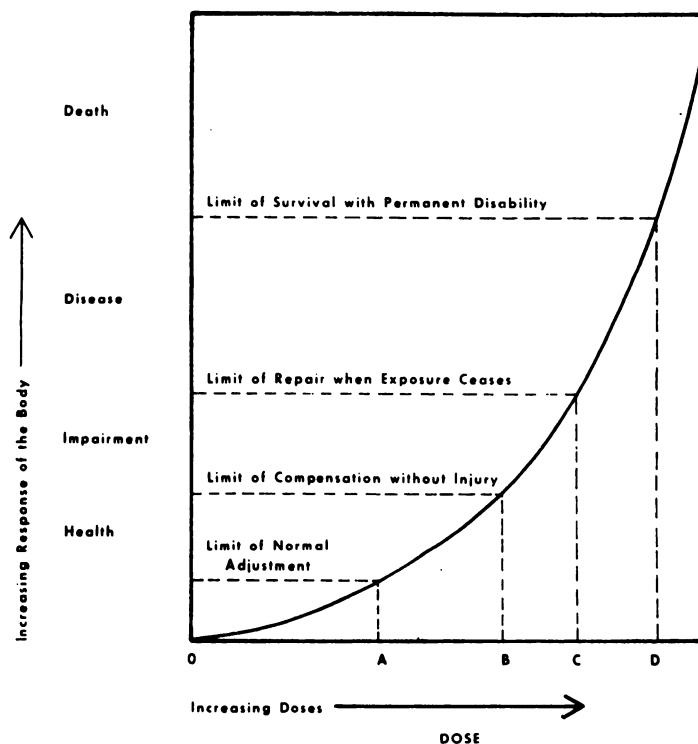


FIGURE 2B. DOSE-RESPONSE RELATIONSHIP

FILL IN THE BLANKS

THE FACT THAT THE BODY WILL RESPOND DIFFERENTLY DEPENDING ON THE AMOUNT AND TYPE OF A SUBSTANCE CAN BE SHOWN BY A _____ - _____
RELATIONSHIP.

Answer: dose-response

12B

The body is continuously working to keep things constant even though it is exposed to various doses of different substances. It does this by changing the heart rate, the respiration rate, and eliminating chemicals from the body. People differ in their ability to perform these functions. This is partly due to age, an individual's health and diet, and partially because of inherited characteristics.

13B

Because these differences exist, there are great variations in the effect of the same dose of chemicals on different people. This is the result of individual differences. It is never absolutely certain that a particular level of exposure will not injure a person because of the occurrence of individual differences. Also, certain substances have little if any harmful effects on the body if the body is only exposed to that particular substance. However, certain substances in combination with other substances can become harmful. This is called a synergistic effect.

FILL IN THE BLANKS

THE FACT THAT CERTAIN SUBSTANCES AFFECT PEOPLE IN DIFFERENT WAYS IS THE RESULT OF _____ WHEREAS THE COMBINATION OF CERTAIN SUBSTANCES PRODUCING A TOXIC EFFECT IS THE RESULT OF A _____
EFFECT.

Answer: individual differences,
synergistic

Threshold Limit Values

In order that exposure to substances is kept at a safe and reasonable level, permissible exposure values, or more correctly, Threshold Limit Values (TLV's) have been established. Threshold Limit Values, according to the American Conference of Governmental Industrial Hygienists, "refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed without adverse effect."

More specifically, TLV's represent the amount of a substance to which normal, healthy adults can be exposed during an 8-hour day throughout their working lives without the possibility of harm.

FILL IN THE BLANK

THE ESTABLISHED GUIDE USED WHEN SAMPLING FOR CHRONIC EXPOSURES OF HARMFUL SUBSTANCES IS THE _____ FOR A PARTICULAR SUBSTANCE.

Answer: TLV

15B

Each year there is a list adopted that indicates TLV's for over 400 toxic substances. These TLV's will give permissible concentrations in certain units of measurement. For example, vapors or gases are expressed as parts per million (ppm) in the air. Particles of solid or liquid matter such as dust, fumes, and mists are expressed as milligrams per cubic meter of air (mg/m³).

FILL IN THE BLANKS

TLV'S ARE EXPRESSED IN _____ AND _____.

Answer: ppm, mg/m³

16B

Ideally, the reason for TLV's is to prevent an individual from experiencing harmful irritation, narcosis (stupor or unconsciousness), nuisance, or any impairment of health resulting from overexposure to potentially harmful substances.

A certain number of workers may experience only discomfort from a certain concentration of a substance at or below the threshold limit whereas others, probably a smaller number, may develop an actual occupational illness.

Again, TLV's should usually be used as guides. However, there are certain substances that have what is called a ceiling value. This value is one that should not be permitted to be exceeded for any reason or for any length of time. Such substances are designated with the letter "C" before the name of the substance when looking at information concerning TLV's. Also, when looking at TLV information, substances that can enter the body by absorption through the skin are identified by the designation "SKIN," following the name of the substance.

FILL IN THE BLANKS

EXPOSURE LIMITS THAT SHOULD NOT BE EXCEEDED FOR ANY REASON OR FOR ANY LENGTH OF TIME ARE CALLED _____.

Answer: ceiling values

18B

Time weighted averages, or an average taken by sampling concentrations at certain times during an individual's period of exposure at work, permit what are called excursions above the TLV for certain substances. This simply means that an individual is allowed to be exposed to more of a certain substance than the TLV allows. However, for the amount of time during the day the exposure exceeds the TLV, an equal amount of work time must also be spent at an exposure level less than the TLV during the day. There is, however, a limit to the excursion that is allowed above an established TLV, and in some cases excursions can be calculated over a workweek rather than a workday.

The excursion, or amount the TLV's can be exceeded at times without injury to health, depends on the nature of the substance, whether or not at high concentrations it will produce acute poisoning, how many times these high concentrations occur, and the length of time of the exposure.

FILL IN THE BLANK

AT TIMES TLV'S CAN BE EXCEEDED CAUSING _____ ABOVE THE TLV FOR A PARTICULAR SUBSTANCE.

Answer: excursions

Some substances, when they exceed a recommended TLV, cause physical irritation but not physical injury or harm. Even if this is the case, such substances should be watched closely because it is believed that the physical irritation caused may in fact aid in the development of actual physical harm. These substances are classified as nuisance particles. They are particles of solid or liquid matter that occur in the workplace and can be inhaled but produce no harmful effect over long periods of time.

Because these particles can accumulate, there should be some control placed on the amount breathed by an individual. When, for example, the amount of SiO_2 (silica) in a dust sample is less than 1 percent, the recommended TLV for that substance is 10 mg/m^3 . The particular TLV for less than 1 percent silica also applies to other substances found in the air that have no specific threshold limit such as portland cement and limestone.

CIRCLE THE CORRECT ANSWER

INDIVIDUALS WORKING WITH LIMESTONE WOULD MOST LIKELY COME IN CONTACT WITH:

- A. NUISANCE PARTICLES
- B. IRRITANTS
- C. ASPHYXIANTS
- D. NONE OF THE ABOVE

Answer: A

There are also several gases and vapors that act as simple asphyxiants causing unconsciousness or death if present in high concentrations due to lack of oxygen. An example of such a substance is nitrogen. However, a TLV for nitrogen may not be recommended because in this case the factor determining asphyxiation is the availability of oxygen. Carbon monoxide, on the other hand, is an example of a chemical asphyxiant with a TLV of 50 ppm. In this case, oxygen is not a limiting factor because carbon monoxide actually prevents the body from utilizing oxygen.

Added stress from such physical factors as heat, ultraviolet and ionizing radiation, humidity, pressure, and vibration actually can change or alter threshold limits. In fact, most of these physical stresses actually act to increase the harmful response of a substance.

FILL IN THE BLANKS

THRESHOLD LIMITS CAN ACTUALLY BE CHANGED BY _____;
HOWEVER, TLV'S ARE NOT EVEN RECOMMENDED FOR _____
BECAUSE AVAILABILITY OF OXYGEN IS THE MAIN FACTOR.

Answer: physical stress, simple asphyxiants

LET'S PAUSE AND REVIEW THE INFORMATION THAT HAS BEEN COVERED TO THIS POINT.

1. THE ABILITY OF A SUBSTANCE TO CAUSE INJURY IS TERMED _____,
WHEREAS A _____ OCCURS IF IT IS POSSIBLE THAT A SUBSTANCE WILL
CAUSE INJURY.
2. INDUSTRIAL POISONING USUALLY OCCURS WITHOUT _____ ACTION BY AN
INDIVIDUAL.
3. THE THREE MAIN ROUTES OF ENTRY ARE _____,
AND _____.
4. MATCH THE POTENTIAL HEALTH HAZARD ON THE LEFT WITH ITS PRIMARY ROUTE OF
ENTRY TO THE BODY ON THE RIGHT BY PLACING THE LETTER OF THE ROUTE OF
ENTRY ON THE LINE PROVIDED IN FRONT OF THE HEALTH HAZARD. (ROUTES OF
ENTRY MAY BE USED MORE THAN ONCE.)

_____ (1) EATING LUNCH IN A WORK AREA	A. INHALATION
_____ (2) AIRBORNE CONTAMINANTS IN WORK AREAS	B. SKIN ABSORPTION
_____ (3) SOLVENTS USED TO CLEAN HANDS	C. INGESTION
_____ (4) EATING CANDY BARS IN WORK AREAS	
_____ (5) SOLVENTS USED TO CLEAN WORK CLOTHING	

5. THE SEVERITY OF A TOXIC SUBSTANCE DEPENDS ON THE _____ OF THE SUBSTANCE IN THE BODY.
 6. INCREASING THE DOSE OF A TOXIC SUBSTANCE WOULD TEND TO CAUSE AN ADVERSE REACTION TO _____.
 7. INDIVIDUAL DIFFERENCES CAUSE PEOPLE TO REACT _____ TO SUBSTANCES THAT ENTER THE BODY.
 8. THE AMOUNT OF A CERTAIN SUBSTANCE TO WHICH A PERSON CAN BE EXPOSED DURING AN 8-HOUR WORKDAY IS INDICATED BY THE _____ FOR THAT SUBSTANCE.
 9. TRUE/FALSE - CEILING VALUES CAN, ON OCCASION, BE EXCEEDED FOR SHORT PERIODS OF TIME. _____
 10. TRUE/FALSE - NUISANCE PARTICLES DO NOT HAVE ESTABLISHED TLV'S DUE TO THE FACT THEY CAUSE NO PHYSICAL HARM. _____
-

- Answers:
- | | |
|---|----------------|
| 1. toxicity, hazard | 6. increase |
| 2. voluntary | 7. differently |
| 3. inhalation, skin absorption, ingestion | 8. TLV |
| 4. C, A, B, C, B | 9. false |
| 5. amount | 10. false |

If the correct answers to these questions were not clear, review before moving ahead to the next frame.

Before moving ahead, remember that in Section A there were four basic classifications of stress: chemical, physical, biological, and ergonomic. Three of these classes of stress (chemical, physical, and ergonomic) are more common in the mining industry than biological stress. For this reason, the final parts of Section B will deal mostly with the recognition of certain health hazards in these three areas.

Chemical Hazards

Chemical hazards occur when there are excessive airborne amounts of mists, vapors, gases, or solids in the form of dusts or fumes. These chemical substances can cause inhalation or respiratory problems resulting from a lack of oxygen or harmful contaminants in the air. They can also be swallowed causing irritation and damage to the body. In addition, they may also act as skin irritants or become harmful as a result of absorption through the skin. This is the case with some solvents.

CIRCLE THE CORRECT ANSWER

CHEMICAL SUBSTANCES CAN CAUSE

- A. RESPIRATORY PROBLEMS
- B. IRRITATION OR HARM FROM INGESTION
- C. IRRITATION OR HARM FROM SKIN ABSORPTION
- D. ALL THE ABOVE

Answer: D

Solvents

Due to the widespread industrial use of solvents, the possibility of a health hazard exists. Therefore, to get a particular job done safely using solvents depends on the proper selection, use, handling, control, and understanding by the employee of what solvents are made of.

The word solvent means a substance which can dissolve another substance. Most solvents are organic compounds (compounds containing carbon). Some examples are benzene, carbon tetrachloride, and gasoline. The most common solvent, however, is water. Because there are so many solvents being used, it is a good practice to always label a solvent for recognition so that the user will know the name and composition of the substance.

FILL IN THE BLANKS

AN ORGANIC COMPOUND THAT CAN DISSOLVE ANOTHER SUBSTANCE IS CALLED A _____
AND DUE TO THE FACT THERE ARE SO MANY, THEY SHOULD BE _____ TO INSURE
SAFE USE.

Answer: solvent, labeled

Labeling of solvents indicating what they are made of, their effect on an individual's health, and whether or not they present a fire hazard is very important. In fact, an individual really should not use any solvent that is not properly labeled due to the health hazard that could result. For example, if a labeled harmful solvent had been repeatedly used on the job and then a less harmful unlabeled one substituted in its place, but at some later date an unlabeled harmful solvent was used again without the workers' knowledge, a health problem would exist. Information concerning solvents being used by the workers in a particular job setting is therefore desirable for a healthy work environment.

Trichlorethylene

Warning! Volatile Solvent

- Avoid prolonged or repeated breathing of vapor.
- Do not take internally.
- Avoid prolonged or repeated contact with skin.

- Use with adequate ventilation.
- This material or its vapor in contact with flames or hot glowing surfaces may form corrosive acid fumes.
- Keep out of reach of children.

First Aid:

Internal: If swallowed, if conscious, make patient vomit immediately by putting finger down throat or by giving warm mustard water or salt water freely. Call a physician immediately. Do not give anything by mouth to an unconscious person. If affected by vapors, move to fresh air. If breathing has stopped, apply artificial respiration.

External: In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. Remove and wash clothing before reuse.

Size

For laboratory or manufacturing use. Not for drug use.

Label No. 318-73

Cat. No.

IT-III80

P

Preiser

SCIENTIFIC, CHEMICAL, MINING AND INDUSTRIAL PRODUCTS

Jones and Oliver Streets • St. Albans, West Virginia 25177

FIGURE 3B. SOLVENT LABEL

FILL IN THE BLANKS

IF SOLVENTS ARE BEING USED ON THE JOB, CARE SHOULD BE TAKEN TO _____
 THE SOLVENTS BEING USED IN ORDER TO HELP PREVENT POSSIBLE _____
 HAZARDS.

Answer: label, health

The physical effects an individual receives from solvent exposure come mainly from skin contact and inhalation of solvent vapors, the gaseous form of liquid. Ingestion is normally not a route of entry for solvents. The immediate physical effects produced from a high level of exposure to harmful solvent vapors are irritation to the respiratory tract as well as possible asphyxiation. Increased exposure over long periods of time, however, can cause paralysis of the central nervous system. Low level exposure to solvents, on the other hand, causes lack of coordination, drowsiness, and other similar symptoms that resemble drunkenness and can lead to an increase in accident proneness on the job. Also, damage to the blood, lungs, liver, kidneys or other critical organs of the body can result from low-level exposure to some solvents.

CIRCLE THE CORRECT ANSWER

WHICH METHOD OF EXPOSURE TO ORGANIC SOLVENTS IS LIKELY TO HAVE THE LEAST PHYSICAL EFFECT ON THE BODY?

- A. INHALATION
- B. SKIN CONTACT
- C. INGESTION
- D. NONE OF THE ABOVE

Answer: C

Due to the possible health hazards that do exist if solvent vapors are present in the work area, detection becomes an important factor. However, when trying to judge whether solvent vapors have reached a dangerous level, neither odor or irritation is an accurate detecting device. Individuals who work around solvents should take the time to learn the exact characteristics of all the solvents they use and the safety precautions that are necessary.

FILL IN THE BLANKS

IN THE DETECTION OF HARMFUL SOLVENT VAPORS, NEITHER _____ NOR _____ PROVES TO BE ACCURATE

Answer: odor, irritation

If a health hazard does exist from the use of solvents, the seriousness of the situation is always a concern. The severity of a hazard that results from using solvents is determined by the following factors:

- How the solvent is used.
- Toxicity of the solvent.
- Type of job which determines how the workers are exposed.
- Work pattern.
- Duration of exposure.
- Operating temperature.
- Exposed liquid surface.
- Ventilation controls used.
- Evaporation rate of the particular solvent.
- Pattern of air flow.
- Concentration of vapor in the work area.
- Housekeeping practices.

The seriousness of a solvent hazard, therefore, is determined partly by the toxicity of the solvent. The conditions of a solvent's use such as who used it, what was used, how and where the solvent was used, and how long it was used, are also important in such a determination.

FILL IN THE BLANKS

THE SEVERITY OF A SOLVENT HAZARD IS DETERMINED BY THE _____ OF THE SOLVENT AND THE _____ OF THE SOLVENT'S USE.

 Answer: toxicity, conditions

Employees working on the job can come in contact with solvents in three different ways. The first is direct contact which usually is the result of hand operations. Examples of this type of contact would be repair of equipment, cleanup of solvent spills, or manual cleaning using cloths or brushes

with solvents on them. The second category is intermittent or infrequent contact that occurs under conditions in which the solvent is semi-contained and exposure can be controlled. Examples of this type contact are spray painting in a spray booth equipped with ventilation, vapor degreasing in a tank with ventilation, or transferring solvents to other than their original containers. The final category is termed minimal contact and is characterized by remote operation of equipment that is isolated from the individual's work area. Contact in this situation is minimal due to the fact the solvent is contained in a closed system and is not released into the working atmosphere. This would tend to occur, for example, in the chemical factories where solvents are produced.

FILL IN THE BLANKS

CONTACT WITH SOLVENTS IN JOB OPERATIONS THAT INVOLVE THE USE OF THESE CHEMICALS ARE CATEGORIZED BY THE METHOD OF CONTACT AS EITHER _____, _____, OR _____.

Answer: direct, infrequent, minimal

Industrial Skin Disease

Remember in Section A that there were two types of dermatitis mentioned: those resulting from a primary irritant and those resulting from sensitization. The main cause of occupational dermatitis in the industrial environment is from chemical agents. Some substances such as solvents and epoxy resin can produce both primary and sensitization dermatitis. Because industrial skin disease accounts for one-half to two-thirds of all occupational illness reported, attention should be given to the recognition of this problem.

FILL IN THE BLANKS

SOLVENTS AND EPOXY RESINS ARE EXAMPLES OF CHEMICALS THAT CAN CAUSE BOTH _____ AND _____ DERMATITIS.

Answer: primary, sensitization

Industrial dermatitis is simply an irritation of the skin resulting from exposure to certain substances (chemical compounds, mechanical, physical and biological agents, and plant poisons) in the work environment. Symptoms of this condition range from a slight reddening of the skin along with mild itching to open sores that may or may not be swollen. In most cases, however, an individual is not able to positively identify the irritant causing the problem from the characteristic appearance of the skin.

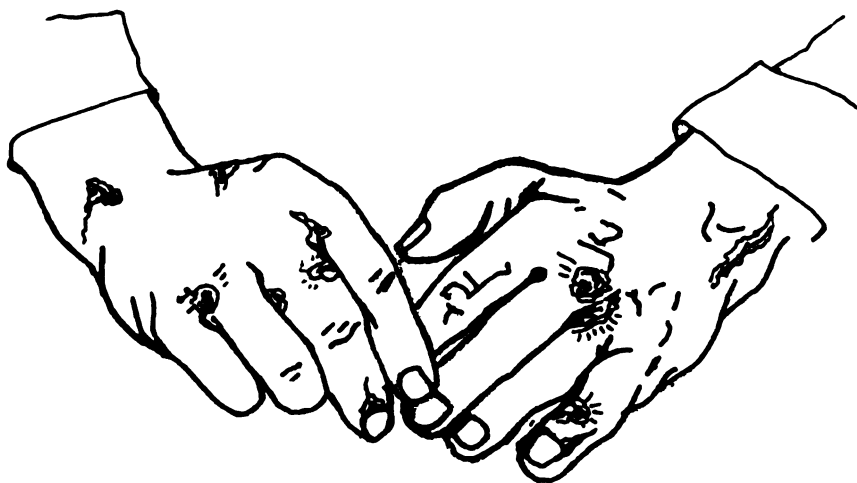


FIGURE 4B. INDUSTRIAL DERMATITIS ON HANDS

If a case of dermatitis is identified at the workplace, a search should begin for the location of possible exposure so that the skin irritants or sensitizers that are being used can be identified. If the cause cannot be found at work, chances are that the dermatitis is due to activities at home. In either case, the individual should receive medical treatment as soon as possible.

FILL IN THE BLANKS

ONCE DERMATITIS IS RECOGNIZED, A _____ SHOULD BEGIN FOR WHATEVER CAUSED THE PROBLEM AND _____ PROVIDED FOR THE INDIVIDUAL AS SOON AS POSSIBLE.

Answer: search, medical treatment

In addition to the irritants that cause dermatitis, there are many indirect factors that interact to produce a skin problem. These indirect causes consist of such things as habits of personal hygiene or pre-existing skin diseases that a person might already have. Examples of indirect causes might be hereditary conditions affecting the skin, acne, eczema, or psoriasis. Nervous disorders can also trigger a reaction that could produce a local or general rash on certain areas of the body.

FILL IN THE BLANKS

IRRITANTS AS WELL AS MANY _____ INTERACT TO PRODUCE DERMATITIS.

Answer: indirect factors

Chemicals, in addition to causing dermatitis, can also cause burns to the skin destroying body tissue. The severity of such a burn depends on the harshness of the chemical, what the chemical consists of, the temperature of the chemical, and the length or duration of the chemical's contact with the body. The burns that result can be either first, second, or third degree. Third degree burns, however, are the most severe.

First degree burns produce redness and heat at the sight of injury along with itching, burning, and pain. Second degree burns are more painful and damage deeper portions of the skin with blisters being formed. Third degree burns are the most severe and involve the actual loss of skin and other body tissue with the area of injury being white instead of red. Third degree burns, however, are not very painful at first because nerves in the area of injury have usually been destroyed or their function impaired. The danger that results to an individual's life from any burn is infection, loss of body fluid, and shock.

BURN CLASSIFICATIONS

Class	Symptoms
First Degree Burns	<ul style="list-style-type: none"> • Reddened outer skin • Swelling
Second Degree Burns	<ul style="list-style-type: none"> • Reddened Skin • Blisters (open or closed) • Damaged underskin
Third Degree Burns	<ul style="list-style-type: none"> • Skin is destroyed • Underskin tissue exposed and damaged • Area may be charred

FIGURE 5B. BURN CLASSIFICATIONS

FILL IN THE BLANKS

IN ADDITION TO CAUSING DERMATITIS, CHEMICALS CAN ALSO CAUSE _____ THAT CAN BE CLASSIFIED AS EITHER _____, _____, OR _____ DEGREE.

 Answer: burns, first, second, third

Chemical burns can also occur to the eye. The eye, however, has a moist surface and tears that help dilute and remove harmful chemical substances. However, if a chemical substance gets into the eye, the immediate recommended action to take is to flood the eye with a lot of low pressure water. This should be done immediately because a delay of only a few seconds might result in severe damage to the eye or even loss of vision.

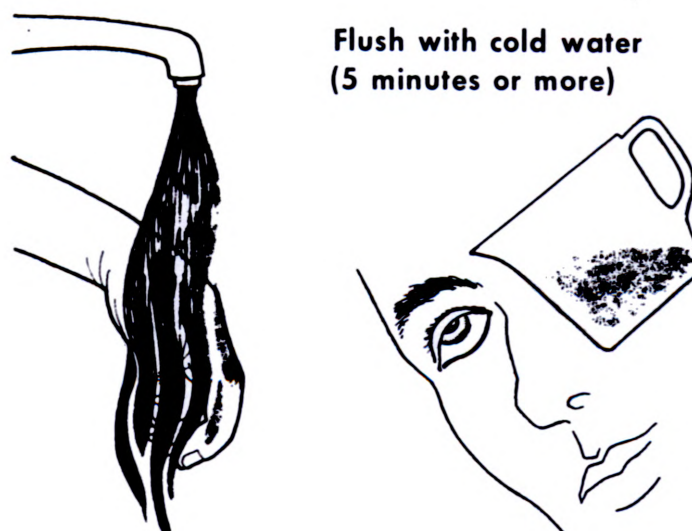


FIGURE 6B. GENERAL CARE FOR CHEMICAL BURNS

FILL IN THE BLANK

THE REMOVAL OF HARMFUL CHEMICAL SUBSTANCES FROM THE EYE IS AIDED BY THE EYE'S MOIST SURFACE AND _____.

 Answer: tears

The use of water is the suggested first step in the treatment of any chemical burn. This represents the only method for limiting the severity of the burn for an individual. Remember, do not hesitate to use large quantities of water; there is no such thing as using too much in such cases.

FILL IN THE BLANK

THE SEVERITY OF ANY CHEMICAL BURN CAN BE LIMITED BY USING LARGE AMOUNTS OF _____ ON THE SITE OF THE INJURY.

Answer: water

38B

Individual differences also play a part in the case of dermatitis in that resistance to irritation varies with the individual. The following factors of susceptibility generally apply:

- Lighter skinned persons are more affected by irritant chemicals than those with dark skin.
- Women have a lower rate of dermatitis, possibly due to their habits of cleanliness, type of work, or the fact they are more willing to seek treatment for skin problems than men.
- A poor diet may cause sensitivity in certain individuals.
- Workers who perspire freely are more susceptible to dermatitis.
- Workers with naturally oily skin are less likely to incur dermatitis, however, this condition can actually contribute to some cases of oil dermatitis.
- Dry skin cracks easily making it more susceptible to infection.

Due to the seriousness of this particular industrial problem, the recognition that a worker's skin disease is directly related to his occupation is the first step in the management of this most prevalent condition.

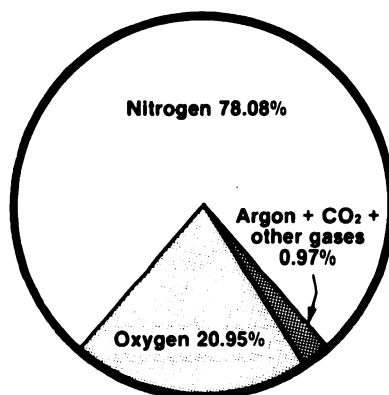
FILL IN THE BLANKS

RESISTANCE TO DERMATITIS VARIES WITH EACH _____ AND THE FIRST STEP IN ITS MANAGEMENT IS _____ OF THE PROBLEM.

Answer: individual, recognition

Gases

In addition to producing vapors and causing dermatitis by skin contact, certain chemicals in the form of gases can also cause an oxygen-deficient atmosphere. In this situation, the oxygen available for breathing is below the level that is considered safe for human exposure and the body is prevented from getting the amount of oxygen it needs to survive. Under normal conditions, air contains approximately 21 percent oxygen. Figure 7B shows the makeup of clean, dry air.



Gas	Symbol	Volume % ¹
Nitrogen	N ₂	78.08
Oxygen	O ₂	20.95
Argon	Ar	0.93
Carbon Dioxide	CO ₂	0.03
Other ²	—	0.01

¹ Cubic feet of gas in 100 cubic feet of air.

² Includes neon, helium, krypton, xenon, hydrogen, methane, nitrous oxide and ozone.

FIGURE 7B. MAKEUP OF CLEAN, DRY AIR

Within a mine, however, the law states the air must contain at least 19.5 percent oxygen, nor more than 0.5 percent carbon dioxide, and no harmful quantities of other noxious or poisonous gases.

TRUE OR FALSE

AIR CONTAINING 20 PERCENT OXYGEN IS CONSIDERED OXYGEN DEFICIENT IN AN UNDERGROUND MINE.

Answer: false

Gases are divided into four groups labeled I, II, III, and IV. The first three are all harmful and are divided according to how easy the harmful amounts can be detected by the senses. Group IV gases are not toxic, but in sufficient quantities, they cause suffocation by replacing oxygen in the air. This type of hazard is created for example by nitrogen, a gas which is not in itself harmful or irritating. In some cases such as surging a tank, the nitrogen can become so abundant in the surrounding atmosphere that it replaces the oxygen which is necessary for breathing. A worker in such an atmosphere can rapidly suffocate and die. The gases which present such hazards are called asphyxiating gases. Some of these are listed below. In high concentrations, some of these gases are also flammable and those are indicated with an asterisk.

Acetylene*	Hydrogen*
Argon	Methane*
Butane*	Neon
Carbon Dioxide	Nitrogen
Ethane*	Nitrous Oxide
Ethylene*	Propane*
Helium	

FILL IN THE BLANK

CARBON DIOXIDE, HYDROGEN, AND NITROGEN ARE GASES THAT CAN CAUSE SUFFOCATION AND DEATH BY PREVENTING ENOUGH OXYGEN FROM BEING IN THE AIR AND THESE HAZARDOUS GASES ARE CALLED _____ GASES.

 Answer: asphyxiating

Physically, the first signs of oxygen deficiency an individual will notice are increased rate and depth of breathing. If an individual is in an atmosphere where there is less than 16 percent oxygen, dizziness, rapid heartbeat, and headache will also be noticed. Oxygen-deficient atmospheres also hinder an individual's movement and can cause a semi-conscious lack of concern about the possibility of death. It is obvious for the reasons mentioned that a worker should not knowingly enter areas of oxygen deficiency without an emergency air supply.

CIRCLE THE CORRECT ANSWER

WHICH OF THE FOLLOWING ARE PHYSICAL SYMPTOMS OF A LACK OF SUFFICIENT OXYGEN?

- A. INCREASED BREATHING AND HEART RATE
- B. DIZZINESS AND HEADACHE
- C. HINDRANCE OF MOVEMENT
- D. BOTH A AND C
- E. ALL THE ABOVE

 Answer: E

42B

When an individual suddenly enters an area containing little or no oxygen, the person usually will not experience any warning symptoms, but will immediately lose consciousness. If the victim is fortunate enough to be rescued and revived, there will probably be no memory of the incident. The senses, therefore, cannot be counted on as an alarm telling a person of an oxygen-deficient atmosphere. This type situation is a definite threat to any miner. Oxygen-deficient atmospheres can and do exist in mine areas where the air is diluted or displaced by gases or vapors or where oxygen is consumed by chemical or perhaps biological reactions.

FILL IN THE BLANKS

AN INDIVIDUAL'S _____ CANNOT BE RELIED UPON AS AN _____
 WARNING AGAINST OXYGEN-DEFICIENT ATMOSPHERE AND AS A RESULT, UPON SUDDEN
 ENTRY INTO SUCH AN AREA, A PERSON WILL USUALLY LOSE _____.

 Answer: senses, alarm, consciousness

43B

Gases, instead of creating an oxygen-deficient atmosphere, can also be a harmful contaminant to the body. These gases are classified as type I, II, or III. Breathing of these gases may cause irritation to the eyes, nose, throat, upper respiratory tract, lung tissue, or even the deep passages of the lung, the air sacs. The possibility of damage depends on the solubility

of the irritant gas in water or how easily it can be dissolved. The more soluble the gas in water, the more quickly it will dissolve in the watery passages of the breathing tubes resulting in damage to the upper respiratory system (example - sulfur dioxide). Insoluble gases, or those that are not easily dissolved, have the capability of being breathed in all the way past the air tubes and reach the air sacs where they cause a severe reaction and damage (example - nitrogen dioxide).

FILL IN THE BLANK

GASES CAN CAUSE IRRITATION AND OR DAMAGE TO THE UPPER RESPIRATORY TRACT, THE AIR SACS, AND EVEN OTHER PARTS OF THE BODY, BUT THE GASES' _____ WILL DETERMINE THE SEVERITY AND SITE OF DAMAGE.

Answer: solubility

Group I gases will make the eyes, nose, and throat sting if they are present at levels near or above the TLV. Ammonia is an example of a gas in Group I. In the case of ammonia, if enough of this gas is present in the air causing a worker's eyes, nose, and throat to sting, inhalation is hazardous. Workers in this situation should immediately leave the area and report the situation.

FILL IN THE BLANKS

GROUP I GASES WILL CAUSE AN INDIVIDUAL'S NOSE, THROAT, AND EYES TO _____ AND IF THIS OCCURS, THE PERSON SHOULD _____ THE AREA IMMEDIATELY AND REPORT THE SITUATION.

Answer: sting, leave

Irritation as the result of group II gases is relatively mild so noticeable irritation is not a good indication of whether the exposure level is safe. An example of a group II gas is nitrogen dioxide. This gas is generated by the burning or setting of explosives and if breathed in, produces an adverse reaction in the tissues of the lungs.

Inhalation of nitrogen dioxide gas, for example, causes a chemical burn to the mucous membranes of the lungs. The nitrogen dioxide reacts with the watery atmosphere of the respiratory tract and air sacs producing nitric acid. In response to this reaction, an acid burn results, causing a release of fluid from the injured tissue.

Pulmonary edema (swelling caused by the release of fluid) then occurs interfering with an individual's oxygen exchange. This can cause suffocation of the victim. Symptoms of pulmonary edema are weakness, cold sweat, nausea, cough with frothy yellow-brown sputum, severe shortness of breath, need for air, and anxiety. Also, recent studies tend to indicate that nitrogen dioxide may speed up the onset of lung cancer and other diseases.

FILL IN THE BLANKS

NITROGEN DIOXIDE IS AN EXAMPLE OF A GROUP _____ GAS AND A GAS SUCH AS THIS PRODUCES AN ADVERSE REACTION IN THE _____ OF THE LUNGS.

Answer: II, tissues

The most dangerous gases are those found in group III. These gases can be present at levels above the TLV, and even cause death, before giving any warning signs of irritation or odor to an individual. An example of a gas in this group is carbon monoxide.

Carbon monoxide is an odorless, colorless, and tasteless gas and as a result, its presence is difficult to detect. It is produced by the incomplete burning of fuels that contain carbon such as coal, wood, paper, oil, natural gas, and gasoline. Carbon monoxide is especially common where vehicles are operated in an enclosed area. This particular gas replaces oxygen in the blood thus interfering with the normal oxygen transfer, causing oxygen starvation to the body within minutes. Its effect, however, does depend on the quantity of gas and length of exposure.

Symptoms of carbon monoxide poisoning include tightness across the forehead, headaches, throbbing in the temples, sleepiness, weakness, rapid breathing, dizziness, nausea, and vomiting. Workers should be familiar with the danger resulting from carbon monoxide, so that if any of the symptoms above are experienced, they can quickly get fresh air and have the job site checked.

FILL IN THE BLANKS

GROUP III GASES ARE CONSIDERED TO BE THE MOST _____ BECAUSE THEY CAN CAUSE _____ BEFORE GIVING ANY WARNING SIGNS OF THEIR PRESENCE.

 Answer: dangerous, death

49B

There are times in the mining industry when various producers of these hazards can and do occur at the same time. For example, explosives, welding operations, and diesel engines release oxides of nitrogen. These nitrogen oxides irritate the eyes as well as the upper respiratory tract. Cough and chest pains are immediate results of exposure to levels above the threshold limit. In the mining industry, as an example, nitrogen oxides also act to impair the bronchial clearance mechanisms, so that dust, created from blasting, is not efficiently cleansed from the lungs. As a result, several harmful effects occur to the respiratory system.

TRUE OR FALSE

VARIOUS LUNG HAZARDS CAN OCCUR AT THE SAME TIME IN CERTAIN MINING OPERATIONS.

 Answer: true

50B

Dusts

Physically, certain reactions will occur to the body as a result of the inhalation of airborne substances. These reactions, however, will vary depending on the type of contaminant, how harmful it is, how much is inhaled, length of exposure, where the contaminant ends up on the body, and how long it remains there. Such reactions would include:

- Cardiopulmonary reactions such as silicosis, asbestosis, and coal workers' pneumoconiosis.
- Systemic reactions caused by harmful dusts from such elements as lead.
- Metal fume fever resulting from the inhalation of fine and freshly generated fumes of zinc or magnesium or of their oxides.

- Allergic reactions caused by inhalation or possible skin contact with organic dust as well as organic and inorganic chemicals.
- Irritation of the nose and throat caused by acid, alkali, dust, or mists.
- Damage to internal tissue resulting from inhaled radioactive materials emitting ionizing radiation.

FILL IN THE BLANKS

THE INHALATION OF AIRBORNE SUBSTANCES WILL CAUSE CERTAIN _____ REACTIONS TO THE BODY THAT WILL _____ DEPENDING ON SEVERAL DETERMINANTS.

Answer: physical, vary

51B

The inhalation of substances in the work area is second only to dermatitis as being the cause for most occupational diseases. Dust that occurs in the workplace vary greatly in size ranging from 0.1 to 25 microns and the smaller particles tend to outnumber the larger ones. Remember, it is respirable dust, those particles that reach the lungs, that causes the most health problems. Respirable dusts that reach the lungs can either pass directly into the bloodstream and be absorbed or they may stay in the lungs and cause damage. Consequently, if dust is visible in the air around a work area, chances are that there are more invisible than visible dust particles present.

FILL IN THE BLANKS

INHALATION OF _____ DUST CAUSES A GREAT NUMBER OF OCCUPATIONAL DISEASES, THEREFORE, _____ DUST IN THE WORKPLACE SHOULD INDICATE TO THE WORKER THE PRESENCE OF _____ DUST.

Answer: respirable, visible, invisible

52B

Recognition of dust exposure depends on a knowledge of the chemical makeup of the dust, its size and concentration, and how it is dispersed. Settling time is an important factor because in order for dust exposure to occur, the particles have to be in the air. Settling time varies with a

particle's size, density, and shape. Particles larger than 10 microns settle quickly. Respirable particles, however, settle more slowly. For example, silica dust five microns in size takes about two and one-half minutes to settle, while silica dust 0.25 microns in size takes about 10 hours to settle.

FILL IN THE BLANKS

SETTLING TIME VARIES DEPENDING ON PARTICLE _____, _____,
AND SHAPE.

Answer: size, density

Lung disease caused by respirable dust is called pneumoconiosis. This term comes from the Greek pneumo - meaning lung, coni - meaning dust, and osis - meaning reaction. Respirable dusts which cause lung disease include, for example, silica, coal, and asbestos fibers. These dust particles must usually be smaller than five microns in order to enter the lungs, with the exception of fibrous materials such as asbestos and talc.

CIRCLE THE CORRECT ANSWER

PNEUMOCONIOSIS IS A LUNG DISEASE CAUSED BY RESPIRABLE

- A. DUST
- B. FUMES
- C. MIST
- D. ALL THE ABOVE

Answer: A

Silicosis, a disease which cripples the lungs, is most often found in non-coal mining environments. The scarring of the lungs that results is caused by the inhalation of fine respirable silicon dioxide dust. This disease may develop either slowly (chronic) or quickly (acute) in its victims. Miners who are exposed to large amounts of very finely divided dust particles of silica are most likely to become victims of the fast-developing type.

Symptoms of rapid-developing or acute silicosis may appear as early as 8 to 18 months after exposure. Shortness of breath is the primary symptom. In the early stages, the victim will be short of breath during physical activity, but this will increase to where it occurs after less and less exertion. Eventually, the condition will advance to the point where the victim is short of breath even while resting. This is caused by the presence of many small round lung scars which are the result of irritation by silica dust. The presence of these scars makes the lungs stiff, requiring more effort to inflate them with air. The walls of the air sacs are also thickened by the scars, blocking the transfer of oxygen into the blood. Thus, low oxygen content in the blood is a characteristic of silicosis. The scars can also join together into larger scars by further reaction to the silica. Some may even occupy an entire lung. This process is called progressive massive fibrosis, and is often accompanied by increased susceptibility to tuberculosis and other infections. As a result, the heart becomes weakened and enlarged by the strain of having to pump more blood to provide the body with a sufficient supply of oxygen.

The development of chronic silicosis is very similar to that of acute silicosis, with the exception of the speed at which it occurs. It may slowly appear after several years of exposure and many more years may pass before it becomes worse.

FILL IN THE BLANKS

LUNG SCARRING CAUSED BY INHALING THE FREE, FINELY DIVIDED DUST OF SILICA IN A MINE MAY CAUSE _____, THE PRIMARY SYMPTOM OF WHICH IS _____.

Answer: silicosis, shortness of breath

Coal workers' pneumoconiosis (black lung) is caused by exposure to the dust of soft (bituminous) coal, which may contain small amounts of silica. Large quantities of this respirable black dust are deposited in the lungs, particularly at the end of the small air tubes just before they enter the air sacs. Due to this peculiar location and the properties of the dust itself, the disease has the characteristics of bronchitis and emphysema as well as those of silicosis. Like silicosis, it leads to scarring of the lungs, which results in stiffening of the lungs and possibly in heart strain.

Hard coal, or anthracite, contains enough silica to cause a lung disease more like silicosis and can cause scars large enough to occupy almost the whole lung. X-rays can detect this disease relatively early; however, the symptoms of respiratory disease usually appear only after several years.

When the small scars of simple coal workers' pneumoconiosis join together to make large masses of scar tissues, complicated pneumoconiosis results. These stony hard masses may occupy more than one-half of the lung. As the scars pull together, the air sac walls behind them tear, causing severe emphysema. Black lung may be complicated, often fatally, by respiratory infections, especially tuberculosis. Cigarette smoking seems to have the effect of making cases of black lung more frequent and more severe among workers who are exposed to coal dust.

Although it was formerly believed by doctors that the amount of lung scarring or disease resulting from coal dust was dependent upon the exact amount of silica contained in the dust, sufficient information has now been collected to indicate that silica-free coal has the ability to produce small scars as well as large ones.

FILL IN THE BLANKS

MINERS WORKING IN SOFT AND HARD COAL ARE EXPOSED TO LEVELS OF RESPIRABLE DUST WHICH CAN CAUSE _____ THAT CAN BE EITHER _____ OR _____.

Answer: pneumoconiosis, simple, complicated

Asbestos is a fibrous mineral whose fibrous strings are very strong. Being heatproof, fireproof, and resistant to most chemicals, it is used in more than 3,000 products, from potholders and children's toys to welding rods and industrial and household insulation. It is present in some form in many factories and homes. For this reason, almost no person is without potential exposure.

Asbestos fibers are extremely fine. They are so fine that one million of them can occupy an inch as compared to approximately 630 human hairs. Because of their very small size, when these fibers are airborne they float like water vapor and do not settle easily. Because they are not trapped by the mucus or hairs of the nose or air passage and are respirable, they can enter the air sacs of the lungs without any trouble causing the disease asbestosis. It is estimated that during an 8-hour shift, at the legal limit of two fibers per cubic centimeter of air, a worker could breathe 15 million fibers, many of which will remain trapped in the lungs. They remain just as indestructible inside the body as they were on the outside. If at the age of 18 a worker breathes in asbestos fibers, chances are these same fibers will still be in the lungs at death.

The body tries hard to isolate asbestos fibers which it cannot destroy. Individual fibers or groups of fibers may, over a period of 10 to 20 years, become surrounded with a thick wall of scar tissue. This scar tissue causes the lungs to lose their ability to expand and contract. The lungs also become hard and smaller than usual. As a result, the lungs hold less air and it becomes harder for the heart to pump blood through them. This makes the transfer of oxygen to the bloodstream difficult. Respiratory infections also become a constant threat to persons with asbestosis, because even minor infections can cause severe shortness of breath and possibly death. Also, the frequency and severity of asbestosis seems to be increased by cigarette smoking.

CIRCLE THE CORRECT ANSWER

THE BODY CANNOT DESTROY ASBESTOS FIBERS AND AS A RESULT

- A. SCAR TISSUE WILL FORM IN THE LUNGS
- B. THE TRANSFER OF OXYGEN BECOMES DIFFICULT
- C. RESPIRATORY INFECTIONS BECOME A THREAT
- D. BOTH A AND C
- E. ALL THE ABOVE

Answer: E

60B

An even more serious effect of asbestos dust is its ability to cause body cells to become cancerous. Scientists are confused as to why this change occurs. It is possible that the reason may be the long period of time that asbestos dust remains in the lungs, or possibly it is the ability of asbestos to absorb other harmful chemicals onto its surface. Perhaps the surface of the asbestos fibers may hold carcinogenic (cancer-producing) chemicals in contact with the body cells and after years of remaining in contact with the carcinogenic chemicals, the cells become malignant (cancerous). However, it is only after a period of 20 to 30 years that workers develop such cancer.

Talc is also an extremely fine dust and, as is the case with asbestos, the smaller particles are the most dangerous to the body. Once these respirable particles of talc reach the lungs, the body is unable to remove them. The lung scarring that results is a lot like that of asbestosis in that the major effects of talc exposure also usually appear after 20 to 30 years.

FILL IN THE BLANKS

ASBESTOS AND TALC ARE SIMILAR IN THAT THEY GENERATE _____.

Answer: fine dust

There are also radioactive dusts and nuisance dusts. Radioactive contaminants can actually be taken into the body as either a gas, dust, fume, or mist. Once inside the body, these contaminants may be deposited in various organs creating a source of internal radiation.

Nuisance dusts on the other hand do not cause lung damage, disease, or harmful effects to the body under normal circumstances. They can, however, if present, cause: a possible reduction in visibility; an unpleasant deposit in the eyes, ears, or nose; or an irritation of the nose, throat, or skin. This occurs because the dust is gritty or because its removal requires hard scrubbing. Also, it should be kept in mind that certain dust, now considered only nuisance dust, may in the future be considered a health hazard. For this reason, any dust continually present in a workplace should be controlled as much as possible to protect the worker's health and well-being.

FILL IN THE BLANKS

RADIOACTIVE DUST, ONCE IN THE BODY, CREATES A SOURCE OF HARMFUL _____, WHILE _____ DUSTS DO NOT USUALLY CAUSE DAMAGE TO THE BODY.

Answer: internal radiation, nuisance

Fumes

Dusts that have a harmful effect on body functions are caused mainly by metal dusts and fumes. It seems that all metal fumes are irritating, specifically when they are freshly produced. Fumes are especially dangerous to an individual because their particles are very fine and as a result can be breathed deep into the respiratory system. The most common hazardous metals found on the job are lead, mercury, beryllium, chromium, cadmium, and manganese.

Fumes, remember, are very fine, solid particles that arise from heating solids such as lead. Fumes are not odorous gases and vapors! When a metal is heated to a high enough temperature, it is vaporized (changed to a gaseous state). This vapor cools shortly and condenses to form extremely fine, solid particles which usually combine with oxygen in the air to form metal oxides. The metal oxide clouds in the air are called fumes.

FILL IN THE BLANK

METALS SUCH AS LEAD CAN HAVE A HARMFUL EFFECT ON THE BODY CAUSED MAINLY BY DUST AND _____.

Answer: fumes

Lead, for example, can enter the body by ingestion and inhalation. Organic lead compound can enter the body by absorption. Once in the body, lead can cause harmful effects to an individual's gastrointestinal, blood, and central nervous system. Swallowing of lead can be a problem or add to an existing problem if personal hygiene is poor in the workplace. Inhalation, however, is the most common route of entry for lead.

Although the body can take care of and eliminate small amounts of lead, if intake is more than elimination, a harmful buildup occurs in the body. If exposure to lead continues over a period of years, poisoning can cause death.

FILL IN THE BLANKS

LEAD'S MOST COMMON ROUTE OF ENTRY IS _____ AND IF EXPOSURE TO THE BODY CONTINUES OVER A PERIOD OF YEARS, LEAD POISONING CAN BE _____.

Answer: inhalation, fatal

Beryllium dust or fumes on the other hand causes disease of the lungs, skin, liver, and kidneys. Of these diseases, however, the effects on the lungs are the most noticeable and disabling. Brief, intensive exposure, or extended exposure to low concentrations of these dusts or fumes can cause acute berylliosis, a severe, pneumonia-like condition of the lungs. Individual susceptibility determines what degree of exposure will cause this disease;

it may in fact be caused by an extremely low amount of exposure in some persons.

The symptoms which are typical of this disease are: cough with phlegm (which may contain blood), severe shortness of breath, and loss of weight over the first few weeks. Although the victim is seriously ill, chest X-rays may be normal at first. Oxygen transfer into the blood may be blocked if the lung inflammation is severe. This disease is often fatal but the victim who does recover most likely will have permanent damage to the lungs.

After a period of exposure from 1 to 20 years, the worker may develop chronic berylliosis. Abnormalities, however, may appear on X-rays many years before symptoms appear. The symptoms may be initially mild, progressing slowly to a more severe and disabling illness. The chronic inflammation causes the lungs to become stiff and unable to transfer oxygen to the bloodstream. After years of overworking in order to pump blood through the inefficient lungs, the heart becomes enlarged, leading to eventual heart failure.

FILL IN THE BLANKS

A SEVERE PNEUMONIA-LIKE INFLAMMATION OF THE LUNGS CAUSED BY AN INTENSIVE OR EXTENDED EXPOSURE TO LOW CONCENTRATIONS OF BERYLLIUM IS CALLED _____, HOWEVER, AFTER EXPOSURE FOR A PERIOD OF 1 TO 20 YEARS _____ MAY DEVELOP.

Answer: acute berylliosis, chronic berylliosis

Fumes are also produced during welding from the vaporization of the metal or compound in the area of the arc. A fume can also be formed when materials such as magnesium metal is burned or when welding or gas cutting is done on galvanized metal. There are also many instances where hot welding vapors react with the air to form oxides. Lead oxide fumes, for example, are produced during smelting and iron oxide fumes are given off in the course of arc welding. These oxides do affect the lungs but not all oxides are disabling.

The degree to which fumes evolve and are produced depends on the welding process, the composition of the filler metal, the flux coating or shielding gas, the electrode coating and the composition of the material being welded. The presence of corrosion products, oil, grease, paint metallic coatings, or process chemicals will vary the composition of the fumes.

FILL IN THE BLANK

DURING THE WELDING PROCESS, VAPORIZATION OF THE METAL IN THE AREA OF THE ARC PRODUCES _____.

Answer: fumes

69B

The effects of some metal fumes appear to be temporary. Metal fume fever is a condition that lasts only a few hours to several days. It is caused by a brief, high exposure to freshly generated metal fumes such as zinc, magnesium, or their oxides. Usually, the symptoms appear within 4 to 12 hours after exposure. New workers are susceptible during the first few days of work and older workers who have been away from the job may develop the reaction. Typical symptoms are chills and fever, nausea, vomiting, body aches, and heavy perspiration. Complete recovery is usually made within a day and artificial immunity is commonly developed after one or two fevers. This immunity will disappear in about five days if there is no contact with the fume within that time (examples: vacation, layoffs, strikes).

The primary treatment for metal fume fever is prevention. Apparently, the fever is caused only from the inhalation of extremely fine particles, freshly formed as fume. Adequate ventilation is therefore the principal means of prevention of metal fume fever.

FILL IN THE BLANKS

SHORT EXPOSURE TO A LARGE AMOUNT OF RECENTLY PRODUCED METAL FUMES CAN CAUSE _____ AND THE BEST WAY TO TREAT THIS CONDITION IS _____.

Answer: metal fume fever, prevention

70B

Mists

Unlike fumes, mists are formed when finely divided liquids are suspended in the air. If inhaled, harmful mists, found wherever corrosive liquids are sprayed, bubbled, splashed, or foamed, can severely irritate the nose, throat, and lungs. For example, the steam from a degreasing tank can carry a mist that is harmful if inhaled. The use of solvents and spray painting are other situations in which hazardous mists can occur.

TRUE OR FALSE

MISTS DIFFER FROM FUMES IN THE SIZE OF PARTICLES THAT ARE SUSPENDED IN THE AIR. _____

Answer: false

71B

Oil mists also occur in industry when mineral oils are sprayed on metal as machine aids and coolants. When used for this purpose, the heat that is produced from the work process breaks down the oil mist which may cause an irritation to the lungs if inhaled. In high concentrations, these oil mists might cause a form of pneumonia and lung scarring. It is hard to detect oil in the air, but generally if the air feels oily, conditions are hazardous.

72B

It is obvious, therefore, that workers who work around corrosive liquids check for any burning sensation when they first enter their work area. This is important because after continuous exposure, dangerous exposures to mists may go unnoticed.

TRUE OR FALSE

MISTS ARE FORMED FROM EITHER FINELY DIVIDED LIQUIDS OR SOLIDS AND AS A RESULT HARMFUL MIST CONDITIONS CANNOT BE DETECTED BY A WORKER IN THE WORKPLACE.

Answer: false

73B

LET'S PAUSE NOW AND REVIEW THE RECOGNITION OF CHEMICAL STRESS.

1. TO COMPLETE A JOB SAFELY USING SOLVENTS DEPENDS ON

A. PROPER SELECTION	D. PROPER LABELING
B. PROPER HANDLING	E. ALL THE ABOVE
C. PROPER CONTROL	

2. THE METHODS OF SOLVENT EXPOSURE THAT PRODUCE THE GREATER PHYSICAL EFFECT ON THE BODY ARE _____ AND _____.
3. THE MAIN CAUSE OF OCCUPATIONAL DERMATITIS IS FROM _____ EXPOSURE.
4. INDIRECT FACTORS THAT CONTRIBUTE TO DERMATITIS ARE _____ AND PRE-EXISTING _____.
5. RESISTANCE TO DERMATITIS VARIES WITH THE INDIVIDUAL, THUS MAKING _____ AN IMPORTANT FACTOR WHEN CONSIDERING DERMATITIS.
6. GASES ARE DIVIDED INTO FOUR GROUPS AND BASICALLY CAN EITHER BE _____ OR CAUSE _____ BY REPLACING OXYGEN IN THE AIR.
7. UPON ENTERING AN OXYGEN-DEFICIENT AREA, A PERSON USUALLY WILL NOT HAVE ANY WARNING BUT WILL IMMEDIATELY _____.
8. GASES THAT IRRITATE A PERSON'S EYES, NOSE, THROAT, UPPER RESPIRATORY TRACT, LUNG TISSUE, AND AIR SACS ARE FOUND IN GROUPS
 - A. I, II
 - B. I, III
 - C. I, II, III
 - D. NONE OF THE ABOVE
9. THE MOST DANGEROUS GASES ARE FOUND IN GROUP _____.
10. SOLUBLE GASES TEND TO AFFECT THE _____ AND _____ GASES TEND TO AFFECT THE AIR SACS.
11. SECOND ONLY TO DERMATITIS AS THE LEADING CAUSE OF OCCUPATIONAL DISEASE IS _____ OF HARMFUL SUBSTANCES.
12. WHICH OF THE FOLLOWING DUST SAMPLES WOULD SETTLE FIRST?
 - A. .75 MICRONS OF COAL DUST
 - B. 5.0 MICRONS OF TALC
 - C. .33 MICRONS OF SILICA
 - D. 1.0 MICRONS OF NUISANCE DUST
13. PNEUMOCONIOSIS IS A LUNG DISEASE CAUSED BY THE INHALATION OF RESPIRABLE _____.

14. GAS-LIKE EMISSIONS CONTAINING VERY SMALL, SOLID PARTICLES THAT CAN BE BREATHED INTO THE LUNGS ARE CALLED _____ AND THEY ARE DANGEROUS AND IRRITATING WHEN THEY ARE GENERATED AND INHALED.
15. WHEN CORROSIVE LIQUIDS ARE USED ON THE JOB, THERE IS ALWAYS THE POSSIBILITY OF FINDING FINELY DIVIDED LIQUIDS SUSPENDED IN THE AIR CALLED _____.

-
- Answers:
- | | |
|------------------------------------|---|
| 1. E | 9. III |
| 2. skin contact, inhalation | 10. upper respiratory system, insoluble |
| 3. chemical | 11. inhalation |
| 4. personal hygiene, skin diseases | 12. B |
| 5. individual differences | 13. dust |
| 6. toxic, suffocation | 14. fumes |
| 7. lose consciousness | 15. mists |
| 8. C | |

If the correct answers to these questions were not clear, review before moving ahead. The next area of this section deals with recognizing physical hazards.

Physical Hazards

A second category of industrial dangers is physical hazards. A good example of this type of hazard is noise. Noise is very noticeable and over time can seriously affect you.

Physical hazards can have either an immediate or long-term effect on a worker's health and safety. These hazards are, therefore, just as important as chemical hazards.

FILL IN THE BLANKS

PHYSICAL HAZARDS CAN HAVE EITHER AN _____ OR _____ EFFECT ON YOUR HEALTH.

Answer: immediate, long-term

Noise and Vibration

We are all constantly exposed to noise (unwanted sound) especially while at work in an industrial environment. In industry, noise in many cases is accompanied by vibration. This double exposure to both noise and vibration can be especially harmful to the human body. Exposure to the combination of jolting and excessive noise, even in small amounts, is uncomfortable and exposure may lead to irritation and the inability to concentrate, resulting in an increase in accidents.

FILL IN THE BLANK

DOUBLE EXPOSURE TO BOTH UNWANTED SOUND AND _____ CAN BE HARMFUL TO THE HUMAN BODY.

Answer: vibration

Sound travels through the air in the form of waves which are similar to those formed by a fish jumping in a pond or by throwing a rock into a pool of water. The larger the stone or fish, the larger and more far reaching are the waves. The same is true of sound waves. These sound waves have the characteristic of frequency (highness and lowness of sound) and Hertz (cycles per second) is the unit used to measure frequency.



FIGURE 8B. SOUND WAVES

FILL IN THE BLANKS

SOUND TRAVELS THROUGH THE AIR IN _____ WHICH HAVE THE CHARACTERISTICS OF _____.

Answer: waves, frequency

The intensity of sound is the pressure that is made when sound is produced. "Loud" noises are noises with lots of pressure, while "soft" noises are noises with little pressure. Sound pressure is expressed in units called decibels. Figure 9B shows some examples of noise levels that may be of interest to you.

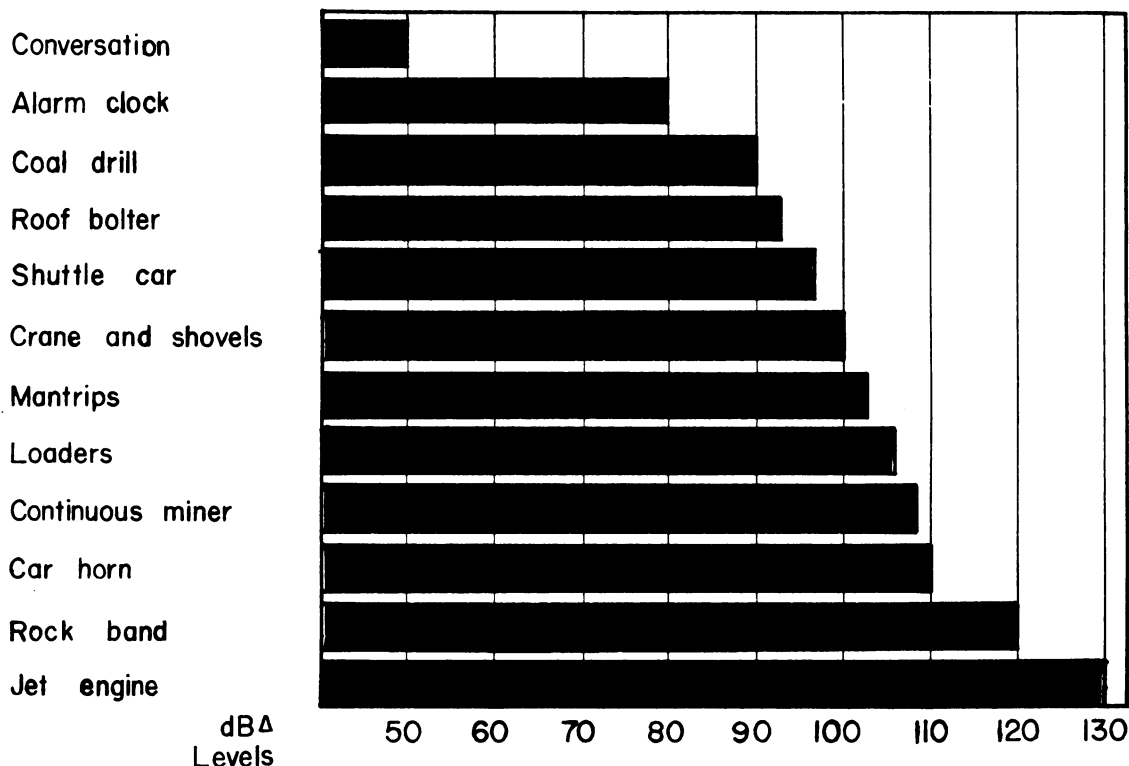


FIGURE 9B. NOISE LEVELS

You will notice that sounds produced by an active rock band, a large jet motor, and a pneumatic hammer have the highest dBA rating. That means the sounds made by these things have the highest intensity. To you this would mean they are the noisiest. Sound then has the characteristics of both frequency and intensity.

FILL IN THE BLANK

SOUND PRESSURE IS EXPRESSED IN UNITS CALLED _____.

Answer: decibels

The ear can be expected to do its job for a lifetime with only gradual hearing loss due to old age (presbycusis). The modern industrial environment, however, can sometimes present more abuse to the human ear than it can cope with.

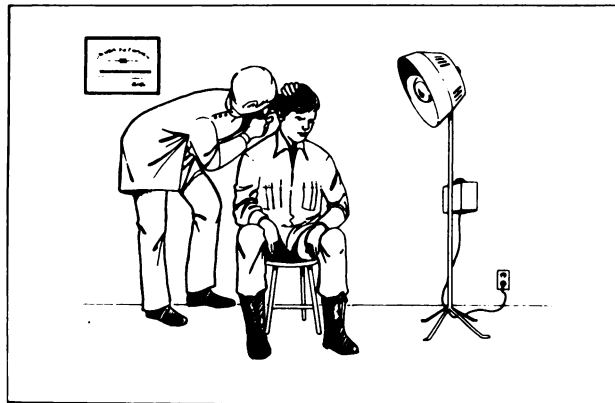


FIGURE 10B. HEARING DAMAGE

The body reacts with shock in the form of tension, stress, and anxiety to loud noise. As a result an individual's blood pressure goes up in the presence of loud noise. Noise also interferes with voice instruction and signals, thus hindering communication.

Noise can also put enough strain on the nerves of the inner ear to cause a temporary hearing loss. Finally, extremely loud and sudden noise can actually break the eardrum. However, the factors that relate to the amount of hearing loss are the type of noise, its intensity, and a person's length of exposure. Overexposure, however, is the major cause of hearing problems.

CIRCLE THE CORRECT ANSWER

A FACTOR THAT DOES NOT RELATE TO THE AMOUNT OF HEARING LOSS IS

- A. LENGTH OF EXPOSURE
- B. NOISE INTENSITY
- C. TYPE OF NOISE
- D. SIZE OF EARDRUM
- E. NONE OF THE ABOVE

Answer: D

Without a break from continuous exposure to noisy conditions, a temporary hearing loss can become permanent after several years. In fact, workers employed in noisy industrial occupations such as mining are suffering permanent hearing loss. However, if your job causes you, on occasion, to enter and leave the noisy work environment during work, it will probably take twice as long for a hearing loss to occur.

COMPLETE THE SENTENCE

WITHOUT A BREAK FROM CONTINUOUS NOISE, A MINER'S TEMPORARY HEARING LOSS CAN

Answer: become permanent after several years

Noise that stops and starts (intermittent) at different times must be recognized as different from continuous, impact, and impulse noise. Intermittent noise is not continuous and its level of sound pressure changes slowly.

A continuous noise, for example, is one that you might hear all day long at the workplace. This could be something like the noise that a preparation plant makes. In continuous noise, the sound intensity level tends to remain pretty much the same all the time.

Impact noise is the kind of noise you hear when someone slams a car door or when someone strikes metal with a hammer. The sound intensity varies greatly in impact noises.

The kind of noise that is made when explosives are set off or when a gun is fired is called impulsive noise. Figure 11B illustrates these types of noise.

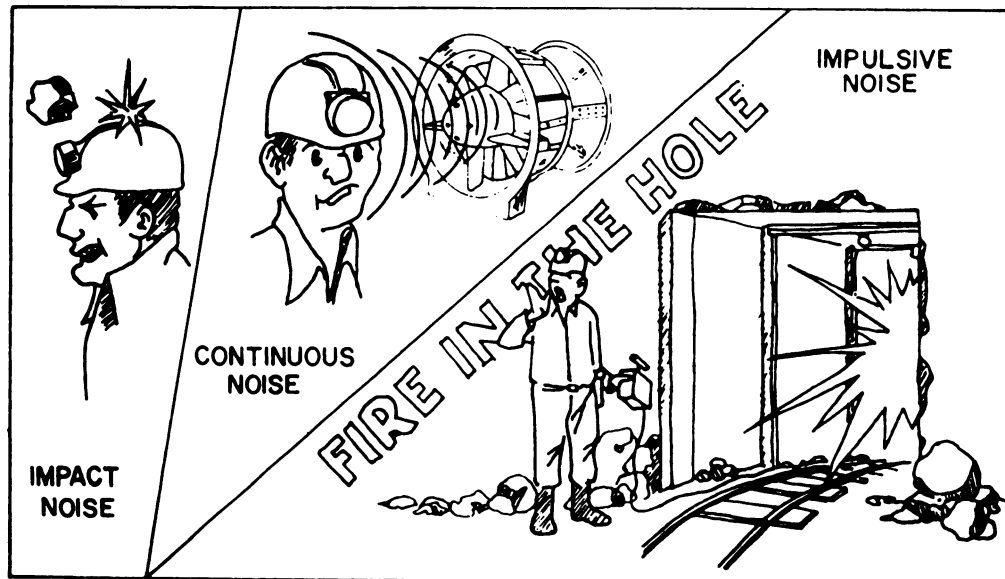


FIGURE 11B. TYPES OF NOISE

Workers exposed to impact and impulse noise do suffer hearing loss. However, we do not know whether the loss is equal to, greater than, or less than the hearing loss from steady noise.

FILL IN THE BLANKS

FOUR DIFFERENT TYPES OF NOISE ARE _____, _____, _____, AND _____.

Answer: continuous, intermittent,
impact, impulsive

The physical hazard associated with noise that also presents a problem is vibration. These vibrations are measured in cycles per second. When standing or sitting on a vibrating surface or holding a vibrating tool, vibrations are transmitted to your body. Broad vibrations, those less than three cycles per second, can cause the whole body to move. This may induce motion sickness.

Vibrations of four to 12 cycles per second caused, for example, by a rock drill can, depending on their direction and the position of the affected person, cause hips, shoulders, and abdominal parts to move. These vibrations are transmitted to the bones and joints and cause alternating movement of the bone ends against the smooth material of joint surfaces (cartilage). As a result, both skeletal and muscular systems, as well as some living cartilage cells, may be damaged or destroyed. The affected area may also become inflamed, causing increased damage and repeated exposures can lead to arthritis.

FILL IN THE BLANKS

BROAD VIBRATIONS CAN CAUSE _____ SICKNESS AND REPEATED EXPOSURE TO FASTER VIBRATIONS OF FOUR TO 12 CYCLES PER SECOND CAN CAUSE THE _____, _____, AND ABDOMINAL PARTS TO MOVE.

Answer: motion, hips, shoulders

Vibrations of four to five cycles per second affect the joints of the backbone and also cause the organs of the abdomen to vibrate. Stomach and digestive problems can therefore become a problem among workers exposed to these vibrations. Riding on certain equipment can cause such vibrations. The most serious vibrations, however, are those of 20-30 cycles per second. Such vibrations actually vibrate the skull and can cause loss of vision. If sufficiently intense, your whole body vibrates and permanent physical injury can result. However, vibrations this severe are not common in the mining industry.

FILL IN THE BLANKS

VIBRATIONS OF FOUR TO FIVE CYCLES PER SECOND NOT ONLY CAN DAMAGE THE JOINTS OF THE BACKBONE, BUT CAN ALSO CAUSE _____ AND _____ PROBLEMS. LOSS OF VISION CAN BE CAUSED BY VIBRATIONS OF _____ CYCLES PER SECOND.

Answer: stomach, digestive; 20-30

Temperature and Pressure

Other physical stresses common in the work environment are temperature and pressure extremes. During surface mining, and in some underground mines, varying temperature and pressures exist that can have an effect on an individual's work and perhaps his health.

For example, in an experiment, a number of miners were loading mine cars in a moisture-saturated worksite at various environmental temperatures. The work output of miners dropped from 100 to 20 percent as the air temperature was raised from 80°F to 95°F.

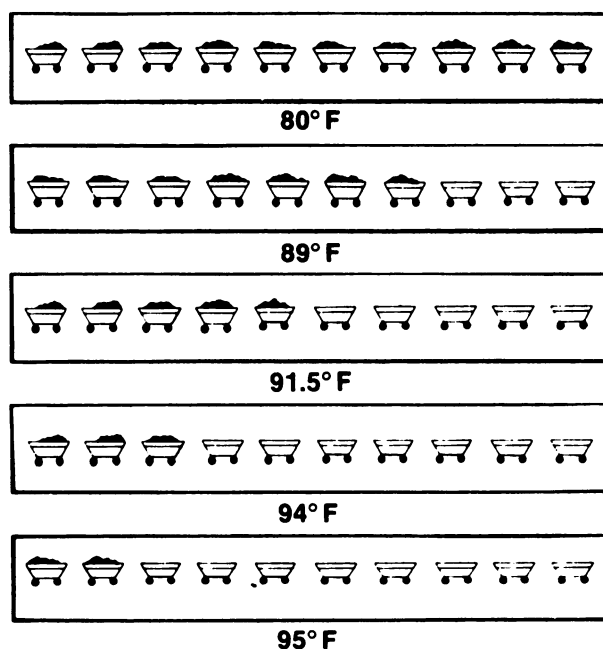


FIGURE 12B. WORK OUTPUT

In order to maintain a constant internal temperature, your body has certain heating and cooling mechanisms. These mechanisms can cope with a limited range of environmental temperatures. The range of comfortable temperatures is narrow and varies greatly depending on your level of activity, the humidity, and air movement. Humidity, or the amount of moisture in the air, along with air movement, relate to bodily comfort in that they affect

the rate at which the body loses heat. Lower temperatures are preferred for more active work because body activity generates heat. However, temperature extremes, either high or low, can result in life threatening conditions.

FILL IN THE BLANKS

AN INDIVIDUAL'S LEVEL OF ACTIVITY, THE HUMIDITY, AND AIR MOVEMENT ALL AFFECT THE RANGE OF _____.

Answer: comfortable temperatures

In the mining industry, you may work in areas that are too warm. Let's look at how your body adjusts to heat.

Heat is naturally produced within the body. The body then either loses heat to the environment or gains heat from the environment. The three main ways that heat is lost from the body is through convection, radiation, and evaporation.

FILL IN THE BLANKS

ALTHOUGH HEAT IS NATURALLY PRODUCED BY THE BODY, HEAT CAN EITHER BE _____ TO THE ENVIRONMENT OR ADDITIONAL HEAT CAN BE _____ FROM THE ENVIRONMENT.

Answer: lost, gained

Convection means that the warm heat produced by your body will flow away toward areas of lower temperature. The body also receives radiant heat from the sun which is absorbed by the skin. When heated, the skin will give off a large amount of radiant energy.

Your body's most efficient method of heat loss however is evaporation. When water is heated, the heat energy transforms it into water vapor. As sweat turns to vapor, it removes heat from the skin thus leaving the skin cooler.

CIRCLE THE CORRECT ANSWER

WHICH OF THE FOLLOWING REPRESENTS THE BODY'S BEST WAY OF GETTING RID OF HEAT?

- A. EVAPORATION
- B. RADIATION
- C. CONVECTION
- D. INFILTRATION

 Answer: A

89B

Another bodily reaction that helps an individual get used to the heat in a new environment is the process of acclimatization. This process helps the body make certain adjustments in order to maintain normal temperature (98.6°F) when exposure to heat is more continuous.

Acclimatization usually takes 4 to 6 days and it occurs most easily in young people. However, an individual's acclimatization is lost when their exposure to heat is discontinued. Upon entering a hot environment again, an individual has to go through another acclimatization process.

FILL IN THE BLANK

A MINER WHO IS NOT USED TO WORKING IN A HOT ENVIRONMENT IS ABLE TO GET USED TO MORE CONTINUOUS HEAT BY THE PROCESS OF _____.

 Answer: acclimatization

90B

Changes in the circulatory system also help cool your body. Small blood vessels near the surface of your body enlarge (dilate), bringing more of the "hot blood" near the skin, allowing some heat to return to the environment. Dilation of these blood vessels makes the heart work harder because of the enlarged circulation area. To compensate, blood vessels to internal organs such as the liver, stomach, and intestines shrink. Damage to these organs may result if they are deprived of sufficient blood for an extended period of time.

FILL IN THE BLANK

LOSS OF HEAT FROM YOUR BODY CAN BE INCREASED BY THE _____ OF BLOOD VESSELS NEAR THE SKIN SURFACE.

Answer: enlargement

91B

If these heat control mechanisms fail, one of several types of heat reactions may occur. The type and severity of the reaction depends on: (1) the conditions of exposure, (2) the degree of your activity, and (3) the individual way your body responds.

COMPLETE THE FOLLOWING SENTENCE

WHEN A HEAT REACTION OCCURS, THE THREE THINGS DETERMINING ITS TYPE AND SEVERITY ARE _____, _____, AND _____.

Answer: conditions of exposure, degree of activity, individual response

92B

Heat stroke, sometimes called sun stroke, is the most serious of the heat reactions. People who are not acclimatized and are moderately active in hot environments can develop heat stroke. This condition causes a sharp rise in body temperature, confusion, angry behavior, and even convulsions. Symptoms of the condition are warm dry skin with the absence of sweating, severe headache, visual disturbance, increased body temperature, and eventual loss of consciousness. Since heat stroke can be fatal, the victim should be sponged down or given a cold bath as soon as possible and then treated in a hospital. This condition may also be accompanied by prickly heat or heat rash. This rash indicates that an individual has an inflammation as a result of poorly functioning sweat glands.

FILL IN THE BLANK

THE MOST SERIOUS HEAT REACTION IS _____.

Answer: heat stroke

Two milder forms of heat reactions are heat exhaustion and heat shock. Heat exhaustion, also known as heat fainting, is the mildest form of heat reaction. Moderate heat exposure may bring it on, especially in persons physically unfit. The victim feels tired, nauseated, possibly chilly, and their breathing will become fast and shallow. Also, they will have a weak, slow pulse and clammy skin. Recovery should be rapid when the victim is removed from the heat and rests with head lowered.

Heat shock is a form of heat exhaustion which occurs in healthy people not acclimatized or used to working in hot climates. Because of inefficient sweating and inadequate fluid replacement, there is not enough fluid to supply circulation to all body organs. If the victim does not replenish lost salt, cramps, weakness, nausea, headache, fatigue, and dizziness will occur. The victim should be moved out of the heat, and fluid and salt losses replaced.

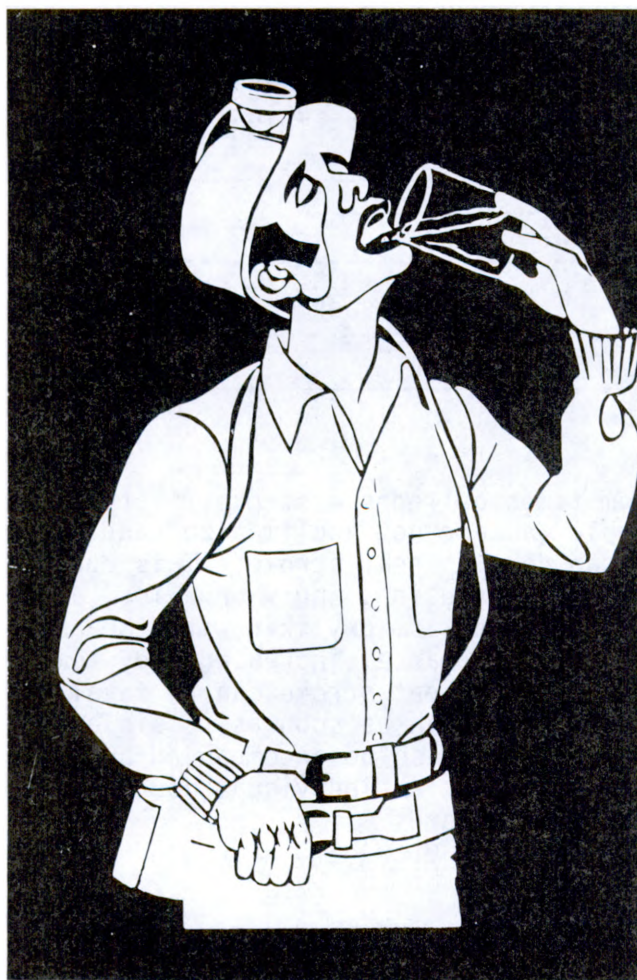


FIGURE 13B. IN HOT WORK SITES, COOL DRINKING WATER CONTAINING 0.1 PERCENT SALT SHOULD BE USED

FILL IN THE BLANKS

OF THE TWO Milder FORMS OF HEAT REACTION, HEAT EXHAUSTION USUALLY AFFECTS _____ PEOPLE WHILE HEAT SHOCK AFFECTS _____ PEOPLE.

 Answer: physically unfit, healthy

94B

At the other extreme of the temperature scale is cold stress. As a whole, your body is less able to adjust to cold than to heat. Basically, you adjust to cold by walking or other kinds of exercising. Your body also attempts to keep you warm through two controls: the shrinking of blood vessels and shivering.

When blood vessels near the surface of the skin shrink, the release of body heat through the skin is slowed down. However, this makes it difficult for blood to reach the hands and feet and causes an individual's hands and feet to become numb. A worker with cold, stiff, or numb hands will be less likely or able to perform manual tasks. Shivering generates body heat as a result of rapid muscle contraction, but again it will be difficult for any worker to do a skilled job while shivering.

FILL IN THE BLANKS

IN ADDITION TO VOLUNTARY EXERCISE, TWO BODY DEFENSES AGAINST EXTREME COLD CONDITIONS ARE _____ AND THE _____ OF BLOOD VESSELS.

 Answer: shivering, shrinkage

95B

One of the two conditions that most frequently result from extended cold exposure is frostbite. Frostbite is local tissue damage, usually to the skin and muscles of either the hands or feet and in some cases both. Sometimes amputation is the only solution. If healing does occur, the affected limb may still be especially sensitive for years.

Another condition caused by long-term exposure to cold is hypothermia. Hypothermia occurs when your body loses heat faster than it can produce it. Often, wet clothing in combination with cool or cold temperatures produces hypothermia. The wet clothing pulls heat out of your body. Uncontrollable shaking, drowsiness, and apparent exhaustion are symptoms of hypothermia. If exposure continues until all energy resources are gone, the cold reaches the brain, creating a lack of good judgment on the part of the individual. However, the individual usually does not realize it and may deny any sickness. Without treatment, the internal temperature of the body falls leading to stupor, collapse, and death. Medical help should be obtained as soon as possible.

FILL IN THE BLANKS

TWO ILLNESSES RESULTING FROM COLD EXPOSURE ARE _____ AND _____.

Answer: frostbite, hypothermia

Some other types of physical hazards are not as obvious as temperature extremes, but are **nonetheless dangerous**. For example, extremes in air pressure may have various side effects. People working under greater than normal pressure are targets for several problems. If the worker returns too quickly to normal air pressure, nitrogen in the body begins to form small bubbles in the blood and tissues of the body. Symptoms vary according to the location of the bubbles. Dizziness, paralysis, unconsciousness, cramps, and choking are all signs of different types of decompression sickness. To prevent this sickness, commonly called the bends, workers must return to normal pressure slowly.

FILL IN THE BLANKS

DECOMPRESSION SICKNESS, COMMONLY CALLED THE _____, RESULTS IN THE FORMATION OF _____ BUBBLES IN THE BLOOD AND TISSUE OF THE BODY.

Answer: bends, nitrogen

Under some working conditions at high pressure, carbon dioxide concentrations may be greatly increased, causing this gas to act as a narcotic, affecting a person's ability to think and make judgments. This condition can be minimized, but not prevented, by maintaining the oxygen concentration at a high level.

A common complaint of those working in existing conditions that are under high pressure is pain and compression in the ears. Blockage of the eustachian tube which connects the middle ear and throat (which can happen when you have a cold or other sinus blockage) prevents the equalization of internal and external pressure. This may result in temporary or permanent hearing loss.

FILL IN THE BLANKS

AT HIGH PRESSURES, CARBON DIOXIDE MAY ACT AS A _____ AND AFFECT A WORKER'S ABILITY TO _____ AND MAKE _____. HOWEVER, PAIN AND COMPRESSION IN THE _____ IS A COMMON COMPLAINT OF THOSE WORKING IN CONDITIONS UNDER HIGH PRESSURE.

Answer: narcotic, think, judgments; ear

Working under less than normal pressure (as is the case at high altitudes) also presents dangers. Oxygen starvation may occur in the thinner air. In areas where tests have shown oxygen concentration to be less than 19.5 percent ("normal" air contains 21 percent oxygen), you need to breathe an oxygen-enriched atmosphere, to prevent impaired senses and judgment. Oxygen starvation may also occur under conditions other than that of reduced pressure. It is not uncommon for workers in industry to experience deficiency of oxygen in the atmosphere of confined spaces. Therefore, you should check the oxygen content of any confined space before entering.

FILL IN THE BLANKS

WHEN WORKING UNDER LOW PRESSURE, WHERE OXYGEN CONCENTRATION IS LESS THAN 19.5 PERCENT, _____ MAY OCCUR. TO AVOID IT, WORKERS MUST BREATHE AN _____ ATMOSPHERE AND BE SURE TO CHECK _____ BEFORE ENTERING.

Answer: oxygen starvation; oxygen-enriched, confined areas

Illumination and Radiation

Sufficient, well-balanced lighting is needed for safe working conditions. Good industrial illumination allows an individual to see comfortably and reduces the chance of losses in visual performance. Poor illumination on the other hand can cause visual fatigue, eye strain and glare, and carelessness due to difficulty in seeing. Poor lighting also causes what is known as a delayed eye adaptation which occurs when you come from a brightly lit environment to one that is dark. A familiar example is the visual change you experience when entering a tunnel while driving on a bright, sunny day.

FILL IN THE BLANKS

SAFE WORKING CONDITIONS EXIST IF THERE IS WELL-BALANCED _____ THAT ALLOWS FOR COMFORT IN SEEING, REDUCING THE LOSS OF _____.

Answer: lighting, visual performance

101B

Good illumination consists of two factors: quantity or amount of illumination, and quality which deals with the distribution of brightness. The amount or quantity of light which is considered to be desirable depends on the type of work that is being done. The highest illumination levels are recommended for tasks involving fine detail, low contrast, or prolonged work periods.

The quality of illumination is concerned with the distribution of brightness in a work area. All elements of brightness have an effect on visibility and the ability to see easily, accurately, and quickly. As a result, fine detail work requires a higher quality illumination than others. In the mining industry, illumination with permissible lighting is required that is sufficient to provide safe working conditions.

FILL IN THE BLANKS

TWO FACTORS OF GOOD ILLUMINATION ARE _____ AND _____, AND IN THE MINING INDUSTRY LIGHTING IS REQUIRED THAT PROVIDES _____ WORKING CONDITIONS.

Answer: quantity, quality, safe

Up to this point, you have been given information concerning hazards that are able to be detected fairly easily by an individual. However, a hazard that cannot be readily sensed but that can cause serious effects to an individual's health and well-being is radiation.

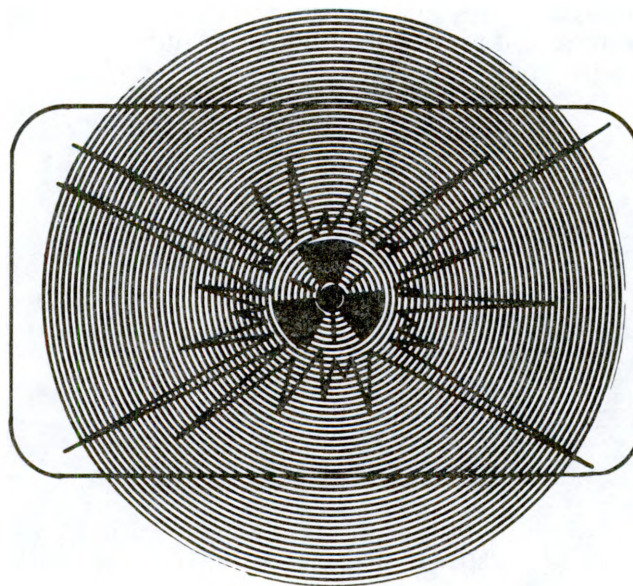


FIGURE 14B. RADIATION

Radioactive materials are frequently present in industry as well as the medical profession. In the mining industry, concentrations of radioactive substances are generally higher in uranium mines than in other underground operations. Radiation in the coal mines of this country usually does not exist. Also, certain special equipment located in some mineral processing plants contain radioactive sources. These nuclear gauges are designed to generate radiation and are used in monitoring certain aspects of the industrial mining process.

FILL IN THE BLANK

A HAZARD THAT CAN HAVE A SERIOUS EFFECT ON AN INDIVIDUAL'S HEALTH AND WELL-BEING AND IS NOT EASILY DETECTED BY HUMAN SENSES IS CALLED _____.

 Answer: radiation

Airborne radiation in underground mining can always be traced to the same source, either uranium or thorium minerals. Traces of these two minerals can be found in almost any kind of soil and rock. Radon and thoron are radioactive gases released by minerals of uranium and thorium. Shortly after their release into the mine air, radon and thoron gases disintegrate. As a result of disintegration, new elements are formed. These new particles are known as radon and thoron daughters. A few seconds after formation, they become attached to the airborne dust in the mine air and can be inhaled by those who work in the area. Thus, airborne radiation is a mixture of these gases and their daughters.

FILL IN THE BLANKS

URANIUM AND THORIUM MINERALS CAUSE _____ IN UNDERGROUND MINES.

Answer: airborne radiation

Radioactive materials emit energy in the form of one of five different types of ionizing radiation: alpha, beta, gamma, X-ray, or neutrons. When this energy is absorbed by cells and living tissues, it causes damage by a process called ionization. As a result of ionization, the radioactive particles that pass through a cell interact with the atoms and molecules which make up that cell and breaks them up. Some radioactive substances, however, only damage certain parts of the body due to how they were absorbed. No matter what the case, radioactivity can permanently destroy a cell or cause it to function improperly. What is frightening concerning ionizing radiation is the fact that when exposed, a person is not able to sense the radiation or the resulting damage to the body.

FILL IN THE BLANK

ALPHA, BETA, AND GAMMA RAYS ARE ALL TYPES OF _____ RADIATION.

Answer: ionizing

The least amount of radiation is exhibited by alpha radiation, which can be stopped by a thin sheet of paper. At least a quarter of an inch of aluminum is required to stop the more penetrating ability possessed by beta

particles. Like X-rays, gamma rays have a deep penetrating ability, and heavy shielding, such as several inches of lead, is required to halt their penetration. As you may know, X-ray technicians stand behind a thick lead shield while working in order to avoid exposure to radiation. This is because of the penetrating ability of X-rays. The last form of radiation, neutrons, are so penetrating that they require special absorbent materials for shielding.

CIRCLE THE CORRECT ANSWER

WHICH OF THE FOLLOWING FORMS OF IONIZING RADIATION WOULD BE LEAST HARMFUL TO A HUMAN.

- A. ALPHA
- B. BETA
- C. GAMMA
- D. X-RAY
- E. NEUTRONS

Answer: A

Alpha particles are hazardous only when taken internally (eaten or breathed in) because they are weakly penetrating. There are some beta particles that are so weak that they also are only internal hazards. Stronger beta particles, gamma rays, X-rays, and neutrons are so penetrating that they are called external hazards. They are able to travel through space and penetrate the body of the person standing nearby, damaging the cells. However, both external and internal radioactive materials have the same damaging effects once inside the body.

FILL IN THE BLANKS

ALPHA PARTICLES ARE CONSIDERED _____ HAZARDS AND PENETRATING RADIATION PARTICLES ARE CALLED _____ HAZARDS.

Answer: internal, external

Most of the radiation hazards that exist in the mines are internal hazards resulting from alpha radiation as is the case of inhaling radon and thoron daughters. However, uranium waste dumps can produce higher than usual concentrations of radioactivity and can emit gamma rays resulting in an external radiation hazard.

TRUE OR FALSE

IN THE MINING INDUSTRY, BOTH INTERNAL AND EXTERNAL RADIATION HAZARDS CAN EXIST.

Answer: true

Because uranium miners are exposed to radioactive hazards, there seems to be a higher incidence of cancer and a decreased life expectancy among these workers. When you consider contributors to lung cancer such as radiation, combining it with cigarette smoking only creates a greater probability for cancer. Thus, people who smoke cigarettes on or off the job while being exposed to hazardous levels of radiation, are about 10 times more likely to get lung cancer. Moreover, lung cancer related to radiation in mining shows up 6 or 7 years earlier among smokers. The following illustration would therefore be most appropriate for uranium miners.



FIGURE 15B. NO SMOKING

These workers also suffer, at young ages, medical changes usually associated with aging. In addition, this radiation can also damage the genetic material of the cells which determines the inherited characteristics of your children. The rate of birth defects and prenatal deaths among children of workers exposed to radiation is twice the normal population rate.

FILL IN THE BLANKS

COMBINING RADIATION WITH _____ CREATES A GREATER PROBABILITY FOR _____.

Answer: cigarette smoking, lung cancer

Another type of radiation, nonionizing radiation, consists of such things as radio waves, visible light, and the infrared or ultraviolet regions of the electromagnetic spectrum. The most common type of nonionizing radiation found in the mining industry is from ultraviolet (UV) radiation. If received in mild doses, this type of nonionizing radiation produces no immediate effect on a worker.

However, UV radiation is absorbed by the first tissue it comes in contact with, the cornea of the eye. As a result, exposure to UV radiation for several hours will produce the sensation of sand in the eye.

The most common cause and source of exposure to UV radiation is from the sun. Individuals whose job requires them to work outside in the direct light of the sun may possibly receive an overexposure to UV radiation. This can cause a painful reddening of the skin (sunburn) and possibly blisters. In industry though, the most common source of UV radiation is from electric welding arcs.

When considering any type of radiation, the best methods of preventing personal harm is separation from the source by distance or shielding. This will reduce the dose and limit the time of exposure.

FILL IN THE BLANKS

THE MOST COMMON TYPE OF NONIONIZING RADIATION IN INDUSTRY IS _____ RADIATION WHICH AFFECTS A PERSON'S _____ AND _____. HOWEVER, THE BEST WAY TO PREVENT HARM FROM RADIATION IS _____ FROM THE SOURCE.

Answer: ultraviolet, eyes, skin; separation

LET'S PAUSE AND REVIEW THE INFORMATION THAT HAS BEEN COVERED CONCERNING RECOGNITION OF PHYSICAL HAZARDS.

1. IN INDUSTRY, EXPOSURE TO NOISE AND VIBRATION CAN LEAD TO IRRITATION AND LACK OF CONCENTRATION THAT CAN RESULT IN AN INCREASE IN _____.
2. FREQUENCY IS THE _____ AND _____ OF SOUND.
3. THE MAJOR CAUSE OF HEARING PROBLEMS IS _____.
4. TRUE/FALSE - IMPACT AND IMPULSE NOISE ARE THE SAME. _____
5. TRUE/FALSE - VIBRATIONS ARE NOT HARMFUL TO THE HUMAN BODY. _____
6. TWO EXTERNAL FACTORS THAT AFFECT BODY CONTACT AND THE RATE AT WHICH THE BODY LOSES HEAT ARE _____ AND _____.
7. THE THREE WAYS THE BODY LOSES HEAT IS THROUGH _____, _____, AND _____.
8. THE BODY GETS USED TO THE HEAT OF A NEW ENVIRONMENT THROUGH THE PROCESS OF _____.
9. TRUE/FALSE - IT IS MUCH EASIER FOR A PERSON TO ADJUST TO A COLD ENVIRONMENT THAN TO ONE THAT IS HOT. _____
10. A COMMON COMPLAINT OF THOSE WORKING UNDER HIGH PRESSURE IS PAIN AND COMPRESSION IN THE _____ WHILE THOSE WORKING IN LESS THAN NORMAL PRESSURE RUN THE RISK OF _____.
11. POOR ILLUMINATION CAN CAUSE
 - A. VISUAL FATIGUE
 - B. EYE STRAIN AND GLARE
 - C. DELAYED EYE ADAPTATION
 - D. CARELESSNESS
 - E. ALL THE ABOVE
12. THE AMOUNT OF RADIOACTIVE SUBSTANCES IS GENERALLY FOUND TO BE HIGHER IN _____ MINES THAN IN ANY OTHER UNDERGROUND OPERATIONS.
13. AIRBORNE RADIATION IS ALWAYS THE RESULT OF EITHER _____ OR _____ MINERALS.
14. WHEN A RADIOACTIVE SUBSTANCE PASSES THROUGH A CELL, IT INTERACTS WITH THE ATOMS AND MOLECULES WHICH MAKE UP THE CELL AND BREAK THEM UP BY A PROCESS CALLED _____.

15. THE MOST COMMON TYPE OF NONIONIZING RADIATION IN INDUSTRY IS _____.

-
- Answers:
- | | |
|---------------------------------------|-----------------------------|
| 1. accidents | 8. acclimatization |
| 2. highness, lowness | 9. false |
| 3. overexposure | 10. ears, oxygen starvation |
| 4. false | 11. E |
| 5. false | 12. uranium |
| 6. humidity, air movement | 13. uranium, thorium |
| 7. convection, radiation, evaporation | 14. ionization |
| | 15. ultraviolet radiation |

If the correct answers to these questions were not clear, review before moving ahead. The final part of Section B deals with the recognition of both Biological and Ergonomic stress.

Biological/Ergonomic Stress

The final part of Section B will deal briefly with the recognition of biological and ergonomic stress factors. Biological stresses such as molds, fungi, bacteria, and viruses can produce many infections and diseases. This form of stress occurs most often in the health occupations or in occupations dealing with animals. However, it may be found in just about any job to some lesser degree.

Examples of where biological stress could be found in the mining industry are in the contamination of potable water supplies or in unsanitary toilets, change rooms, and bathing facilities. Insects, rodents, and snakes can also be found in or around the mine. Interestingly, an example of biological stress recently made national news. The outbreak of Legionnaires disease became a well publicized example in which the air conditioning system of several buildings were contaminated by a certain bacteria. Death and illness were the result.

FILL IN THE BLANKS

THE DANGER OF BIOLOGICAL STRESS IS THAT IT CAN PRODUCE MANY _____ AND _____.

Answer: infections, diseases

In coal mines, according to 30 CFR 75.1712-3, all bathing facilities, change rooms, and sanitary toilet facilities shall be provided with adequate light, heat, and ventilation so as to maintain a comfortable air temperature and to minimize the accumulation of moisture and odors. Such facilities also shall be maintained in a clean and sanitary condition.

Also, according to 30 CFR 75.1718, there shall be an adequate supply of potable water provided for drinking purposes in the active workings of a mine, and such water shall be carried, stored, and protected in sanitary containers.

TRUE OR FALSE

REGULATIONS, IF PROPERLY FOLLOWED, WOULD TEND TO REDUCE BIOLOGICAL HAZARDS.

 Answer: true

114B

Without proper testing equipment and laboratory procedures, sight, taste, and smell can be possible indicators, and in some cases be relied upon to provide an individual with the ability to recognize certain biological hazards. However, control of biological hazards must be considered on an individual basis. The seriousness of a biological hazard is determined by examining the nature of the hazard, the intensity of exposure, and the length of time a worker is exposed.

COMPLETE THE FOLLOWING SENTENCE

THE NATURE OF A HAZARD, ITS INTENSITY OF EXPOSURE, AS WELL AS THE LENGTH OF EXPOSURE DETERMINES _____.

 Answer: the seriousness of a biological hazard

115B

This leads to our last category of industrial hazards that will be discussed in Section B.

Ergonomics deals with achieving the best possible balance, both physical and mental, between the worker and his job. In general, ergonomic stress does not directly produce injuries or diseases. Instead, by putting strain

on the worker, they increase the chance of accidents. The dangers of such ergonomic stress as boredom, fatigue, and work pressure may not be as obvious, for example, as the dangers of harmful chemicals but they must also be prevented.

FILL IN THE BLANKS

ERGONOMICS CONCERNS THE BALANCE BETWEEN THE _____ AND HIS _____.

Answer: worker, job

Ergonomics deals with the relationship of human and machine. Therefore, it is important to realize that routine tasks are generally performed more efficiently by a machine while an individual tends to perform better those tasks that call for responsibility and flexibility.

TRUE OR FALSE

DUE TO THEIR LOW ERROR RATE, ROUTINE TASKS ARE PERFORMED BEST BY EITHER WORKER OR MACHINE.

Answer: false

One source of ergonomic stress is a badly designed work area. When looking at a work area and determining its effectiveness, one should consider space as well as the functional arm, leg, and body movements made by a worker while doing a job.

The effectiveness of any such system that includes man and machine depends on integrating the body characteristics of the worker with the operating equipment and work area. A badly designed work area not only distracts a worker, increasing the chance of accidents, but in some cases can endanger a worker's life.

FILL IN THE BLANKS

INTEGRATING BODY CHARACTERISTICS WITH THE OPERATION OF A MACHINE IS IMPORTANT IN THE PROPER DESIGN OF THE _____.

Answer: work area

Proper body position is also important, especially in lifting and carrying. Unsafe acts are indirect causes of accidents. An example of such an indirect cause is improper lifting of materials. Proper procedures are important to recognize.

It is important to spend some time on the subject of handling materials because this type of accident accounts for more than one-fourth of all mine injuries. Every time a person handles materials, there is some risk involved. This is why back injuries are very common. However, back injuries usually are caused by lifting incorrectly rather than by lifting something that is too heavy.

FILL IN THE BLANK

BODY POSITION IS IMPORTANT IN LIFTING BECAUSE HANDLING OF MATERIALS ACCOUNTS FOR MORE THAN _____ OF ALL MINE ACCIDENTS.

Answer: one-fourth

It is easier to lift a load when you are standing close to it. The same rule applies when you are handling materials in the mine. Bending over, however, is not the way to get close to it. When you bend over, your spine (all the way from your shoulder to your lower back) takes most of the strain.

Instead of bending over when you lift, bend your knees and straddle the load. This way is best because it assures that you will lift with your arm and leg muscles rather than with your back.

Here are some basic procedures for lifting:

1. Keep your feet apart, one alongside and one behind the object. Do not reach out, but stand close to the load.
2. Keep your back straight (nearly vertical). Bend your knees, not your back.
3. Tuck your chin in. This helps keep your spine straight and firm.
4. Grip the object with your whole hand. Fingers have little strength. Lift with your leg and arm muscles instead of your back as much as possible.
5. Tuck your elbows and arms in near your body. Arms held away from the body lose strength.

6. Keep your body weight directly over your feet. This provides more power and ensures a good balance.
7. When changing direction while carrying a load, turn your entire body including your feet and do not turn suddenly.
8. If the load is too heavy or interferes with your normal walking, get help.

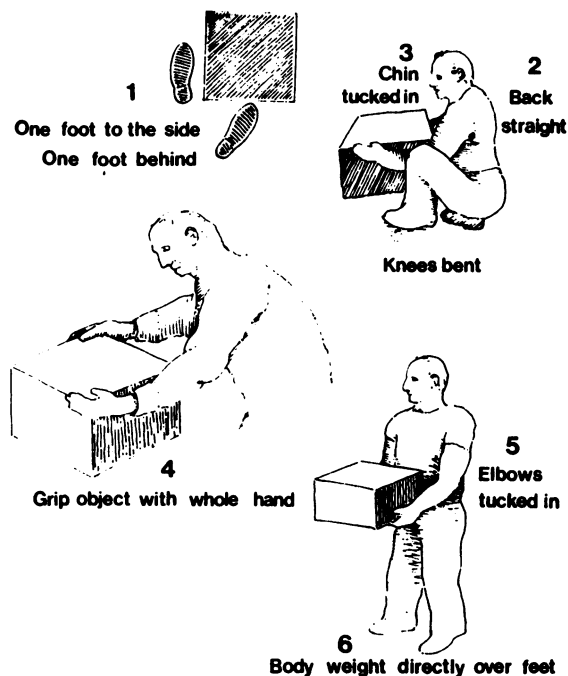


FIGURE 16B. LIFTING

The most comfortable position in doing a job is usually the right one as well as being one that puts the least amount of stress on your body.

TRUE OR FALSE

WHEN HANDLING MATERIALS IN A MINE, BEND DIRECTLY OVER THE OBJECT AND LIFT USING THE MUSCLES OF YOUR ARM. _____

Answer: false

Equipment, therefore, must be designed so that it's comfortable and easy to operate. Monotony and repetitive motion are other ergonomic stresses that lead to boredom, carelessness, and accidents. In addition, when you are worried, it's harder to concentrate on your job and distractions lead to accidents. If you worry too much about how well you are doing your job, probably you will just do worse.

LIST THREE ERGONOMIC STRESSES THAT LEAD TO CARELESSNESS AND ACCIDENTS.

- A. _____
- B. _____
- C. _____

Answer: worry, monotony, repetitive motion,
poor body position, and equipment
design (Any three of these)

Fatigue is another problem common to all workers and it is represented by a decrease in an individual's ability to perform physically. As a result of fatigue, a tired condition exists and in many cases it is accompanied by soreness and pain.

Fatigue, in fact, is the result of an accumulation of effects from various sources. Some of the factors that cause fatigue that should be recognized are: monotony; environmental factors such as light, climate, and noise; the intensity of both mental and physical work; psychological factors such as responsibility, worry, or conflict; and illness, pain, and eating habits.

FILL IN THE BLANK

A TIRED CONDITION THAT IS SOMETIMES ACCOMPANIED BY SORENESS AND PAIN CAUSING A DECREASE IN PHYSICAL PERFORMANCE IS _____

Answer: fatigue

Due to fatigue, an individual might experience increased irritability, depression, or a general weakness in drive and a dislike for work. With this in mind, it is interesting to note that maximum production takes place during the first hours of work when fatigue is lowest. As the shift continues, fatigue increases, production goes down, and the rate and chance of accidents increases.

CIRCLE ONE OF THE CHOICES IN EACH SET OF PARENTHESES:

AS TIME ON THE SHIFT INCREASES, PRODUCTION (INCREASES/DECREASES), FATIGUE (INCREASES/DECREASES), AND THE CHANCE FOR AN ACCIDENT (INCREASES/DECREASES).

 Answer: decreases, increases, increases

All of these industrial hazards--chemical, biological, physical, and ergonomic--threaten your health and safety. If not controlled, they can cause immediate injury or chronic illness. Other hazards (badly designed equipment, work pressure) threaten your safety, causing carelessness and increasing the rate of accidents.

LIST THE FOUR CATEGORIES OF INDUSTRIAL HAZARDS.

- A. _____
- B. _____
- C. _____
- D. _____

 Answer: chemical, physical, biological, ergonomic

BEFORE MOVING AHEAD TO SECTION C, LET'S BRIEFLY REVIEW THE RECOGNITION OF BIOLOGICAL AND ERGONOMIC HEALTH HAZARDS.

1. THE SERIOUSNESS OF A BIOLOGICAL HAZARD IS DETERMINED BY
 - A. EXAMINING THE HAZARD
 - B. THE INTENSITY AND TIME OF EXPOSURE
 - C. BOTH A AND B
 - D. NONE OF THE ABOVE

2. TRUE OR FALSE - ERGONOMIC STRESS PRODUCES MANY DISEASES. _____
 3. TRUE OR FALSE - A BADLY DESIGNED WORK AREA INCREASES THE CHANCE OF ACCIDENTS BUT IN NO WAY ENDANGERS LIFE. _____
 4. TRUE OR FALSE - WHEN LIFTING YOU SHOULD KEEP YOUR FEET APART, KEEP YOUR BACK STRAIGHT, TUCK YOUR CHIN IN, GRIP THE OBJECT TIGHTLY WITH YOUR FINGERS, TUCK YOUR ELBOWS AND ARMS IN, AND DISTRIBUTE YOUR BODY WEIGHT DIRECTLY OVER YOUR FEET. _____
 5. TRUE OR FALSE - FATIGUE CAN CAUSE A PERSON TO BE IRRITABLE, DEPRESSED, AND EVEN DISLIKE WORK. _____
-

Answer: 1. C
2. False
3. False
4. False
5. True

If the correct answers to these questions were not clear, review before moving ahead. If you are satisfied with your understanding of Section B and the recognition of health hazards, it is time now to move on to Section C - Control of Occupational Health Hazards.

INDUSTRIAL HYGIENE
FOR THE MINING INDUSTRY

SECTION C

"EVALUATION AND CONTROL OF HEALTH HAZARDS"

This is Section C of the Industrial Hygiene Course entitled "Evaluation and Control of Health Hazards." The first two sections of this course dealt with a general understanding of what industrial hygiene is and how it is related to the health and well-being of the worker. In this section, we will concentrate on the methods for evaluating and controlling health hazards thus minimizing your exposure to them.

As was the case in the first two sections of this course, you will be asked questions throughout this section. Always answer the questions before checking the correct answer. The knowledge you obtain from this course will aid you in maintaining your health and well-being during your employment in a mining related occupation. Now go on to the next frame.

Evaluation and Measurement

First, let's look at the area of evaluation of health hazards. Evaluation is the process of making a decision concerning the degree or the amount of a health hazard that occurs as a result of an industrial operation such as mining. Evaluation is essentially a tool that is used for interpreting results and for the purpose of conserving the health and well-being of the worker.

CIRCLE THE CORRECT ANSWER

USING AN INSTRUMENT TO DETERMINE THE AMOUNT OF OXYGEN IN THE AIR IS AN EXAMPLE OF THE PROCESS OF

- A. RECOGNITION
- B. EVALUATION
- C. CONTROL
- D. NONE OF THE ABOVE

Answer: B

The extent of any health hazard depends on the nature of the hazard, the amount of exposure, and the length of exposure. In order to evaluate the extent or presence of a health hazard, samples of the contaminant have to be

obtained. The sample location, the time the sample is taken, and the number of samples taken are all important factors in the evaluation process. Determining the length of exposure is also important. This is required in order to determine the dosage of harmful substance that a person receives.

FILL IN THE BLANKS

THE TIME A SAMPLE IS TAKEN, ITS LOCATION, AND THE NUMBER OF SAMPLES ARE IMPORTANT IN THE _____ PROCESS, WHILE LENGTH OF EXPOSURE IS IMPORTANT IN DETERMINING THE _____ A PERSON RECEIVES.

Answer: evaluation, dosage

In order to take proper measurements, it is important to have a good knowledge about the working operation or process in which the measurements are to be taken. Also, the person taking the measurement should have a good knowledge about the contaminant in question. With this in mind, there should be enough measurements taken to establish what is known as the time weighted average. A time weighted average is an average exposure level determined by sampling at certain times during the period of a worker's exposure to a specific contaminant that requires evaluating. These time weighted averages can then be compared to the TLV for the substance in question to determine the extent of the hazard.

CIRCLE THE CORRECT ANSWER

PROPER MEASUREMENTS ARE INFLUENCED BY

- A. KNOWLEDGE OF THE CONTAMINANT
- B. KNOWLEDGE OF THE WORK PROCESS
- C. ESTABLISHING TIME WEIGHTED AVERAGE
- D. ALL THE ABOVE

Answer: D

What is really being measured in such situations is the dosage that a worker receives. In order to accomplish this, certain sampling instruments can be attached directly to the worker and carried throughout the working day accomplishing the job of hazard evaluation. An example is illustrated in Figure 1C in which a dust sampler is attached to a worker to determine dust concentrations.



FIGURE 1C. PERSONAL SAMPLER READY FOR USE

COMPLETE THE FOLLOWING SENTENCE

ONE OF THE BEST WAYS TO MEASURE THE DOSAGE OF A SUBSTANCE A WORKER RECEIVES
THROUGHOUT THE WORK DAY IS TO _____.

Answer: attach a sampling device directly to the worker.

Another method of evaluation is to measure the concentration of a substance in an individual's specific work area during selected intervals. After taking the measurements, the next step is to average the results and compare them to the length of exposure thus determining the time weighted average. An example of this method is shown in Figure 2C which shows the process of noise sampling in an underground mine.



FIGURE 2C. NOISE SURVEY PROCEDURE

COMPLETE THE FOLLOWING SENTENCE

IN ADDITION TO AN ATTACHED PERSONAL SAMPLER, ANOTHER TECHNIQUE USED TO MEASURE DOSAGE IS TO _____.

Answer: take measurements in an individual's
specific work area at selected intervals.

However, several factors could possibly affect the results of an evaluation. Examples of situations that will affect obtaining satisfactory measurements are such things as changing from day shift to night shift, changes in the seasons (winter to summer), changes in the work operation process, or the daily changes that seem to occur in the direction of air movement and temperature. These factors should be taken into consideration when evaluating the work environment.

TRUE OR FALSE

THERE IS A POSSIBILITY THAT THE ACCURACY OF DUST SAMPLES TAKEN DURING TWO DIFFERENT SHIFTS CAN BE AFFECTED.

Answer: True

8C

As was mentioned in Section A and B of this course, chemical hazards are the most numerous type found in the environment. These hazards can be further divided into two categories, the particulates (dust, smoke, mist, etc.), and gases or vapors. These categories also essentially determine how to measure for these particular type of contaminants. Measurements of gases and vapors using direct-reading instruments can be determined more readily than those in the particulate group because of the solubility of these substances.

TRUE OR FALSE

THE FACT THAT A SUBSTANCE IS A GAS OR PARTICULATE ALSO DETERMINES MEASUREMENT TECHNIQUES.

Answer: True

9C

Problems of skin contact also need to be measured. However, these contaminants are much harder to evaluate than exposure to air contaminants. A wipe test might be one method of obtaining a sample for determining contamination levels. This technique is self explanatory and involves wiping the area of suspected contamination and then analyzing the results by laboratory tests. Another method might be laboratory analysis of a worker's clothing. In this situation though, studying the work habits of an individual might provide helpful information leading to the source of contamination.

FILL IN THE BLANKS

THE WIPE TEST AND LABORATORY ANALYSIS ARE TECHNIQUES USED IN EVALUATING _____.

 Answer: skin contamination

10C

In addition to chemical hazards, there are also physical hazards such as heat and cold, radiation, pressure extremes, and noise that need to be evaluated. These hazards are usually measured by direct-reading instruments.

Chemical or physical hazards that do not cause too serious a problem may just be sampled periodically. However, if certain chemical or physical agents have the potential to cause serious difficulty, continuous monitoring might be very desirable.

FILL IN THE BLANKS

MATERIALS THAT DO NOT CAUSE TOO SERIOUS A PROBLEM CAN BE MEASURED _____
 WHILE THOSE THAT CAUSE SERIOUS DIFFICULTY SHOULD BE MONITORED _____.

 Answer: periodically, continuously

11C

Direct-reading Instruments

The direct-reading instruments used to measure or evaluate hazards can essentially be either electrical direct-reading instruments or color-change and stain-length instruments. The information that follows will help familiarize you with such equipment in case you come in contact with any of these instruments on the job.

Those instruments that give a direct reading on a dial with the aid of an electrical meter of some sort are classified as electrical direct-reading instruments. An example of an instrument of this kind used in the mining industry would be one that measures a combustible gas such as methane. Instruments of this type are depicted in Figures 3C(1) and 3C(2).



FIGURE 3C(1). HAND-HELD METHANE SPOTTER

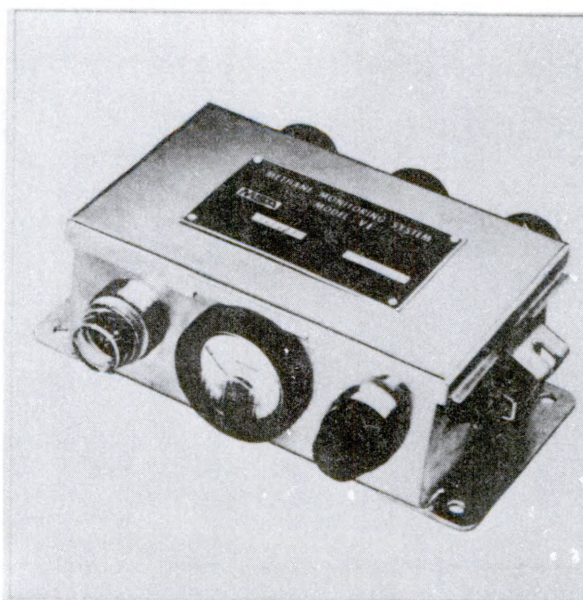


FIGURE 3C(2). MACHINE-MOUNTED METHANE MONITOR

It is important to note, when taking a sample, that the indicator needle on some of these instruments rises sharply and then returns to the zero reading. This could indicate a very rich gas mixture so high that it cannot be read on the scale. However, if the person reading the scale did not see the needle rise and then return to zero, one might falsely assume the air to be safe. Also, these types of instruments have a tendency not to function properly in oxygen-deficient atmospheres. Remember when considering methane, its concentration must not exceed 1.0 volume percent in any working place when tested at a point not less than 12 inches from the roof, face, or rib.

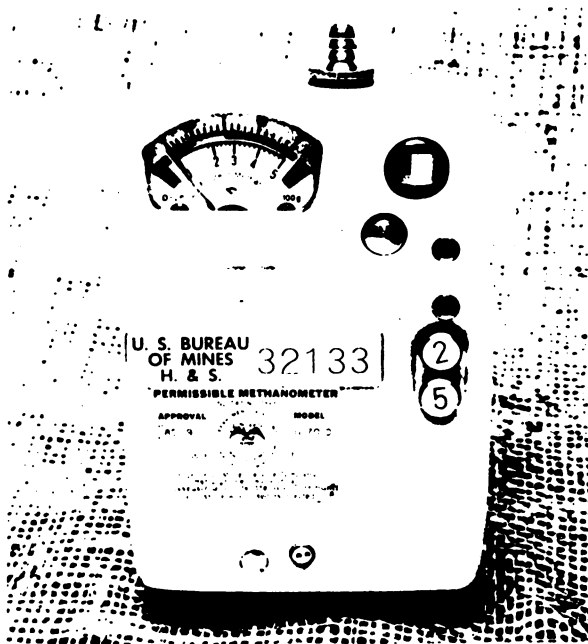


FIGURE 3C(3).
HAND-HELD METHANE TESTER



FIGURE 3C(4).
MINER TESTING FOR METHANE

TRUE OR FALSE

YOU CAN RELY ON ELECTRICAL DIRECT-READING INSTRUMENTS TO GIVE A CORRECT READING IN ALL SITUATIONS AND UNDER ALL CONDITIONS. _____

Answer: False

To monitor an oxygen-deficient atmosphere in a mine, a flame safety lamp is used. This lamp, pictured in Figure 4C(1), indicates the availability of oxygen in a certain area of a mine by the height of the flame. The flame decreases in size in an oxygen-deficient atmosphere and goes out when the oxygen concentration drops below 16 percent. However, with methane present it will burn at 12 percent.

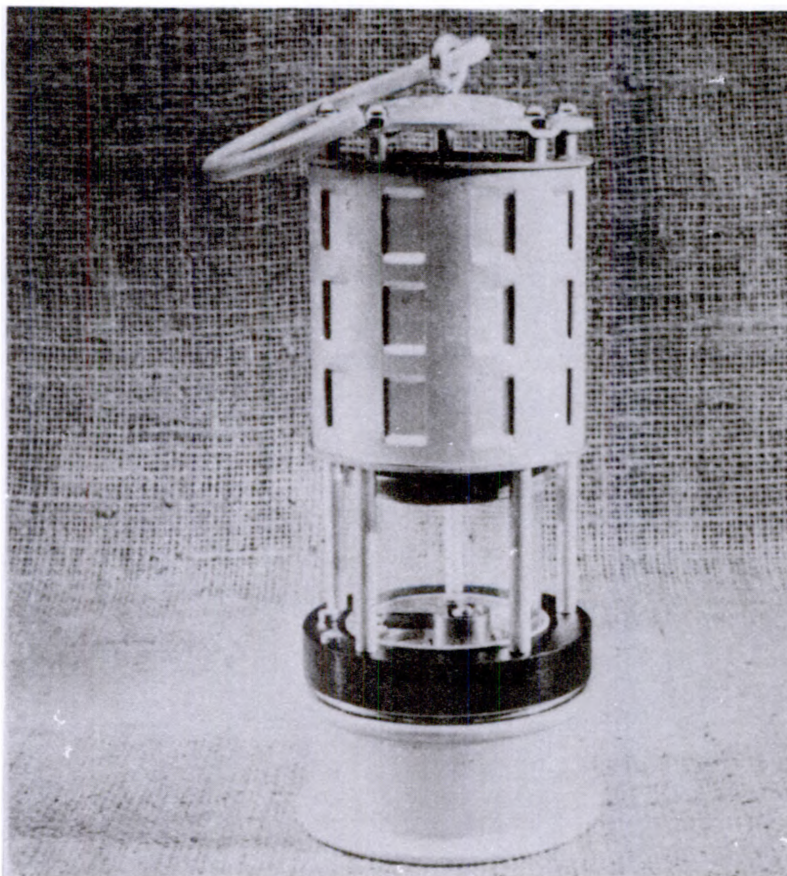


FIGURE 4C(1). FLAME SAFETY LAMP

In order to assist the flame safety lamp in monitoring and measuring an oxygen-deficient atmosphere, an electrical direct-reading instrument called an oxygen indicator is available. Figure 4C(2) shows an example of such an instrument. It is capable of checking atmospheres for oxygen content in the range of 0 to 25 percent.



FIGURE 4C(2). OXYGEN INDICATOR

TRUE OR FALSE

ELECTRICAL DIRECT-READING INSTRUMENTS AS WELL AS VISUAL INDICATORS ARE AVAILABLE FOR DETECTING OXYGEN DEFICIENCY. _____

Answer: True

To be sure a worker in a mine is getting enough ventilation and air to breathe, you have to be able to determine the amount of air reaching the worker. Such a measurement can be taken with an anemometer which measures wind force and speed. Figure 5C(1) pictures an anemometer and Figure 5C(2) shows the measurement procedure.

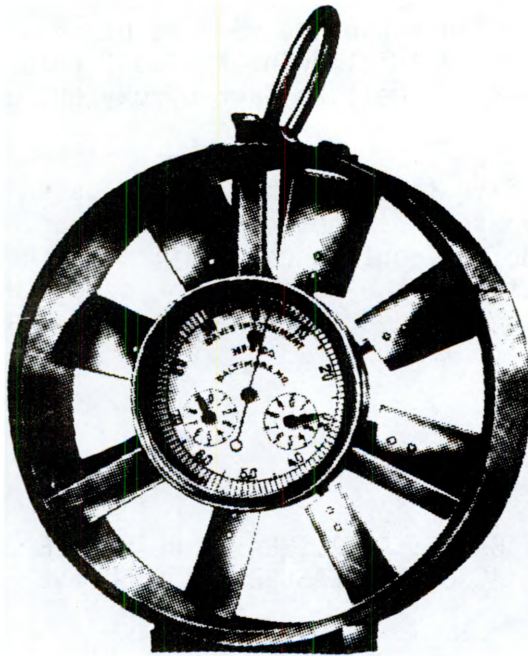


FIGURE 5C(1). ANEMOMETER



FIGURE 5C(2). ANEMOMETER
AIR MEASUREMENT

FILL IN THE BLANK

VENTILATION OR AIR FLOW IN A MINE IS MEASURED BY AN _____.

Answer: anemometer

Instruments that measure flammable gases do not always respond in the same way to different flammable gases. For example, if more than one flammable gas is present in the mine air, this can cause the reading on an instrument to be wrong. This is particularly true following a mine fire or explosion when carbon monoxide and hydrogen, as well as lack of oxygen, all exist.

For best results, these instruments have to be calibrated (adjusted) for the conditions under which they are to be used. If not, the meter reading may be meaningless. With this in mind, do not confuse calibration of the instrument with following operating instructions; they are not the same. However, operating instructions should also be read and followed for the best results.

TRUE OR FALSE

FOLLOWING A MINE FIRE WHICH PRODUCES MANY GASES, A CALIBRATED FLAMMABLE GAS DETECTOR CAN ALWAYS BE COUNTED ON TO GIVE ACCURATE MEASUREMENT RESULTS.

Answer: False

Another potential hazardous condition that exists in the mining industry is respirable dust exposure. Even though the air in a mine is tested and found to be in compliance with the law pertaining to respirable dust, periodic dust monitoring is still required to insure dust levels stay within requirements.

One instrument designed for personal individual dust sampling is the gravimetric dust sampler pictured in Figure 6C(1).

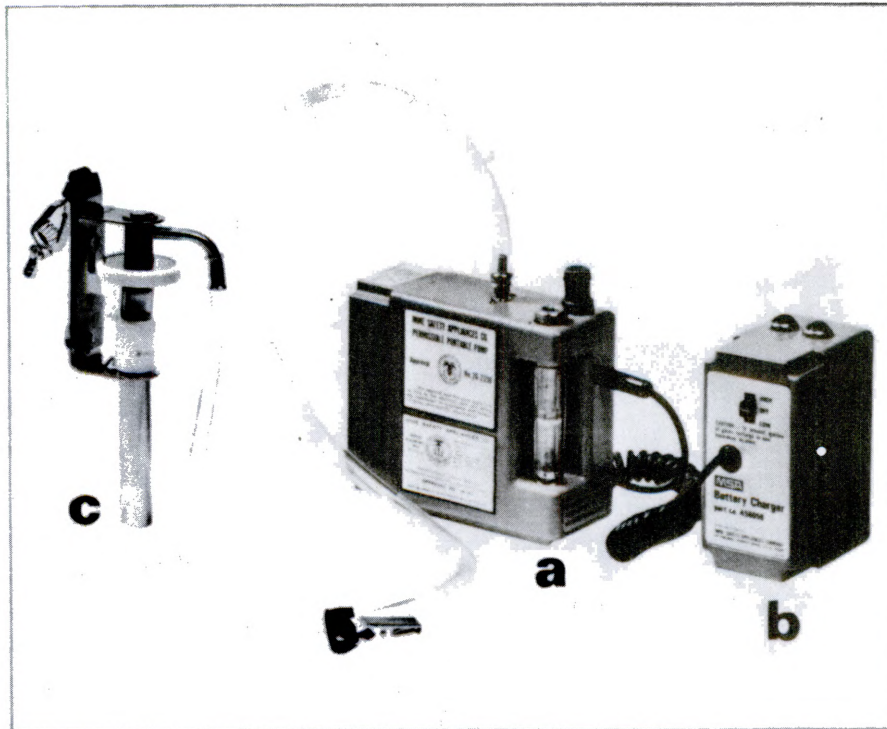


FIGURE 6C(1). GRAVIMETRIC DUST SAMPLER

This instrument consists of (a) a battery-powered pump, (b) a battery charger, and (c) a filter for personal monitoring which is designed to be worn. The pump draws the air through the cyclone where larger dust particles (larger than 10 microns) are removed. Then the smaller particles are trapped on a filter so they can then be weighed to determine the amount of respirable dust per cubic meter of air.

Figure 6C(2) shows another instrument (the MRE Gravimetric Respirable Dust Sampler) that gathers and collects area samples of dust on a filter. This filter is then sent to a laboratory for analysis to determine the level of respirable dust.

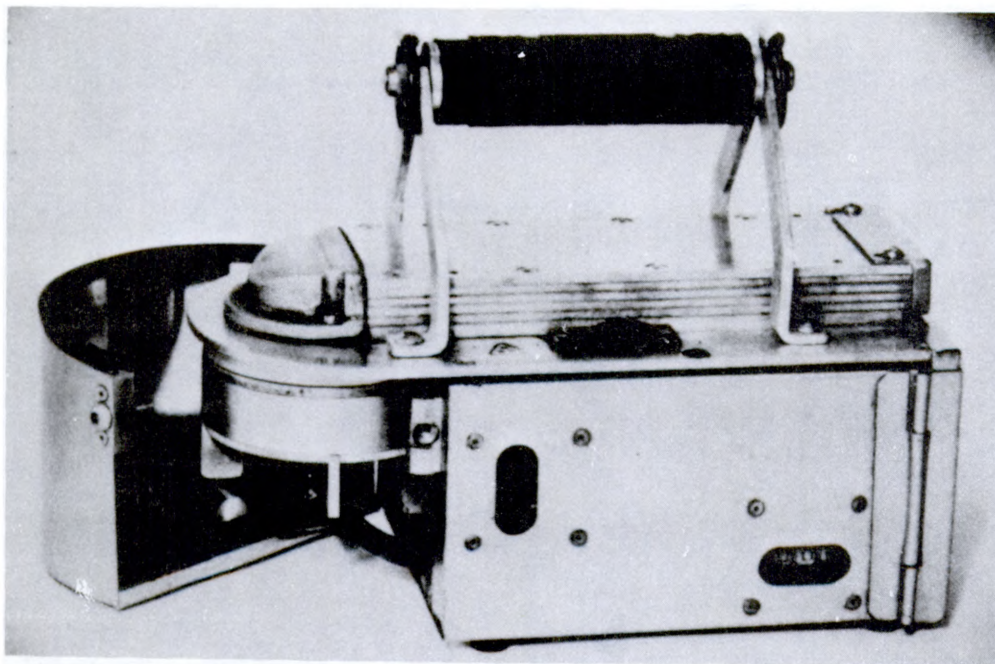


FIGURE 6C(2). MRE GRAVIMETRIC RESPIRABLE DUST SAMPLER

TRUE OR FALSE

ONCE A MINE HAS BEEN TESTED AND DETERMINED TO BE IN COMPLIANCE WITH THE LAW CONCERNING THE AMOUNT OF RESPIRABLE DUST, NO FUTURE MEASUREMENTS ARE REQUIRED WITH ANY DUST SAMPLING DEVICE.

Answer: False

20C

Noise is also a basic health hazard found in the mining industry. Noise mainly affects a person's hearing. However, it can also affect your ability to do a good job by interfering with on-the-job communication, increasing the chances that an accident will occur.

Therefore, to help prevent excessive noise exposure, the law requires that noise sampling be conducted in coal mines. An electric direct-reading instrument used for the purpose of measuring sound levels is a sound level meter like the one pictured in Figure 7C. This instrument is designed to measure decibel (dBA) levels.

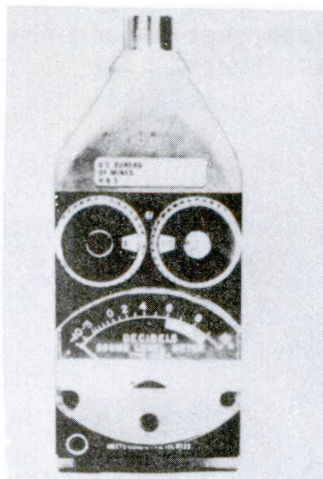


FIGURE 7C. SOUND LEVEL METER

TRUE OR FALSE

IT IS IMPORTANT TO KEEP DECIBEL LEVELS WITHIN PRESCRIBED LIMITS IN ORDER TO PROTECT HEARING AND PREVENT ACCIDENTS.

Answer: True

21C

The audio dosimeter, however, is used to measure total noise exposure during a working shift. It is worn by the miner and the percent of exposure is measured at the completion of the shift.

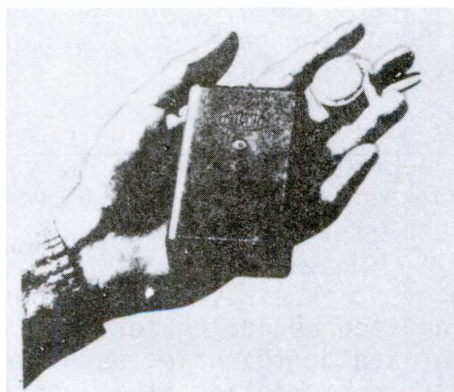


FIGURE 8C. NOISE DOSIMETER

As we have discussed, many health and safety hazards can result from too much noise. Because of this, Federal regulations have been established which limit the time that you are permitted to be exposed to certain dBA levels in the mine.

With this in mind, it is important to note the TLV's for noise. They indicate the decibel levels to which an individual can be exposed for a specific period of time.

Exposure Time (Hours)	dBA
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼ or less	115

For example, if noise is recorded to be 110 dBA, then exposure to it must not exceed 30 minutes during an 8-hour shift.

Once you have worked the number of hours listed at a specified dBA, you must not be exposed to 90 dBA or greater levels during the rest of the work shift.

Noise, however, has an interesting characteristic. If a machine causes a noise exposure of 90 dBA, another machine just like it operating beside it at the same time would only increase the noise exposure by 3 dBA.

FILL IN THE BLANKS

IF NOISE IN A MINE IS RECORDED AT 105 dBA, THEN EXPOSURES IN THAT AREA DURING AN 8-HOUR PERIOD SHOULD BE LIMITED TO _____.

Answer: 1 hour

24C

Radiation, temperature, and pressure are other potential hazards that need to be evaluated in the mining industry to insure healthful conditions for the worker.

Meters are used to measure alpha, beta, gamma, and X-radiation.

Radioactive radon gas found in a mine is often measured by a battery-operated, portable pump like the one pictured in Figure 9C.

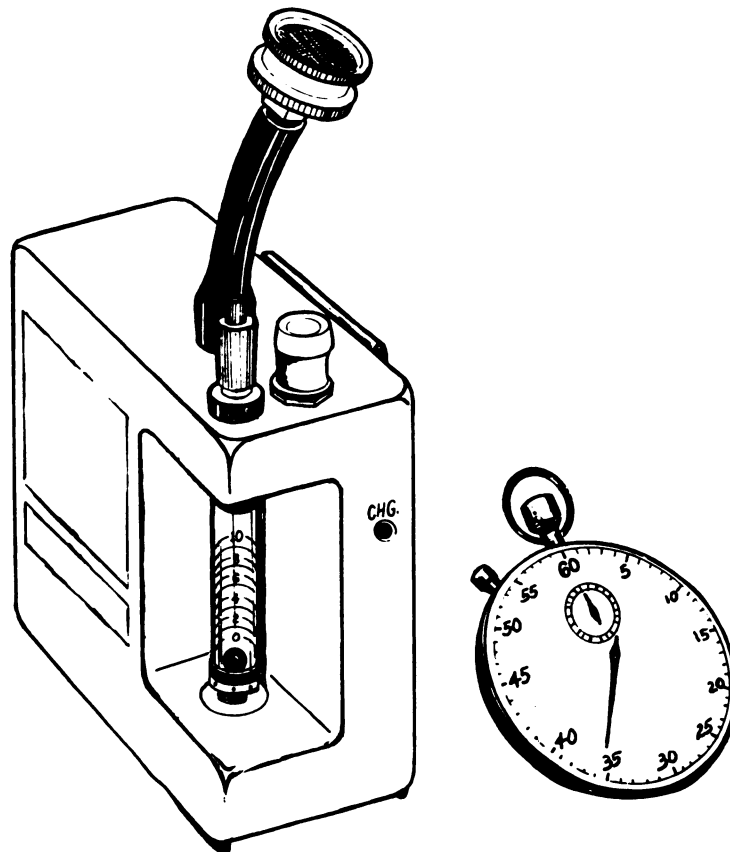


FIGURE 9C. RADIOACTIVE RADON GAS BATTERY-OPERATED,
PORTABLE PUMP

Also, film badges, similar to those small square devices you see attached to the chest pocket of an X-ray technician's lab coat, can be used to measure accumulated amounts or doses of radiation. These badges cannot be used to measure alpha radiation though because alpha particles will not penetrate the film paper used in the badges.

FILL IN THE BLANKS

TWO COMMON WAYS USED TO EVALUATE RADIATION HAZARDS ARE WITH _____ AND _____.

Answer: meters, film badges

Various temperatures can affect how a person does a job, not to mention the amount of work produced. In the mining industry, however, a person is more likely to be exposed to high temperatures than low temperatures.

Air temperature is measured with a thermometer usually referred to as a dry bulb thermometer. Humidity, or the moisture content of the air, is measured with a psychrometer which gives a dry bulb (temperature) as well as wet bulb (humidity) readings. (See Figure 10C.)



FIGURE 10C. SLING PSYCHROMETER

This instrument is slung around in a circular fashion in the air approximately 100 times while holding on to the handle until a stable reading is obtained.

FILL IN THE BLANK

HUMIDITY AS WELL AS AIR TEMPERATURE CAN BE MEASURED BY A _____.

Answer: psychrometer

Atmospheric pressure both high and low should be monitored. A barometer is the instrument used to measure atmospheric pressure. This instrument is referred to every evening on the television weather report.

When working under high pressure, carbon dioxide in the atmosphere may increase enough to cause sleepiness. Congestion in the ears is also common at high pressures. Persons working at reduced pressure may experience oxygen starvation affecting their senses and individual judgment. Deficiency of oxygen from working in confined spaces is also common in industry.

TRUE OR FALSE

BECAUSE OF ITS MINOR EFFECT ON THE BODY, ATMOSPHERIC PRESSURE SHOULD NOT BE CONSIDERED IN EVALUATION OF POSSIBLE HEALTH HAZARDS. _____

Answer: False

All the instruments mentioned and described so far except the film badges, psychrometer, anemometer, MRE dust sampler, gravimetric dust sampler, and the flame safety lamp are electrical direct-reading instruments. The accuracy of electrical direct-reading instruments can be affected by improper maintenance, unreliable workmanship in the manufacturing process, poor calibration, interfering substances in the air, changes in the amount and flow of air, and weak or damaged batteries. The reliability of the measurements obtained are dependent on these factors. Therefore, frequent routine maintenance and calibration is required and necessary for such equipment to insure greater accuracy.

TRUE OR FALSE

READINGS ON A METHANE SPOTTER CAN BE AFFECTED BY POOR CALIBRATION, IMPROPER MAINTENANCE, AND OTHER SUBSTANCES IN THE AIR.

Answer: True

Up to this point we have basically examined electrical direct-reading instruments that give a direct reading on a meter of some kind. We have also mentioned other instruments that collect samples or give direct readings that are used along with the electrical direct-reading instruments.

Other types of detection and identification instruments, color change and stain-length instruments, depend on a chemical reaction to give a reading. The reading or measurement is determined by comparing the color produced when the sample is taken with a standard color. The color and length of stain will tell you what substance has been sampled and how much of the substance is present.

FILL IN THE BLANKS

INSTRUMENTS THAT GIVE MEASUREMENT INDICATIONS BY COLOR CHANGE OR STAIN LENGTH DEPEND ON A _____ TO PRODUCE THE READING.

Answer: chemical reaction

Carbon monoxide is measured by instruments of this type. The most common instrument used for this purpose is one that utilizes a detector tube with a chemical that changes color (from yellow to green) when exposed to carbon monoxide. The shade of green as a result of the test indicates the amount of carbon monoxide. This instrument is pictured in Figure 11C(1).

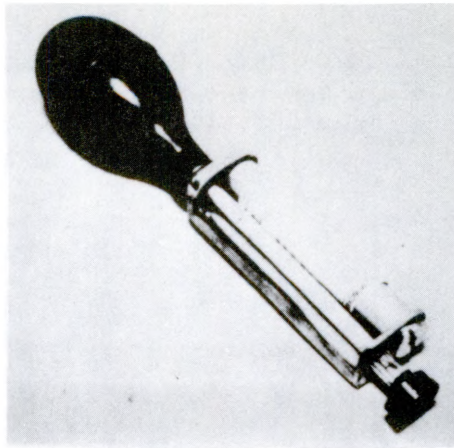


FIGURE 11C(1). CARBON MONOXIDE TESTER

The most common and accurate carbon monoxide detector indicates the length of stain produced by carbon monoxide drawn through a chemical substance in a glass tube. (See Figure 11C(2)).



FIGURE 11C(2). CARBON MONOXIDE LENGTH-OF-STAIN INSTRUMENT

FILL IN THE BLANKS

CARBON MONOXIDE CAN BE MEASURED BY BOTH _____ AND
_____ INSTRUMENTS.

Answer: color change, stain-length

Other length-of-stain indicators are also available for the detection of oxides of nitrogen, sulfur dioxide, and hydrogen sulfide. All are very similar to the ones pictured in Figure 12C(1) and Figure 12C(2) which show a portable length-of-stain hydrogen sulfide detector and nitrogen dioxide detector.

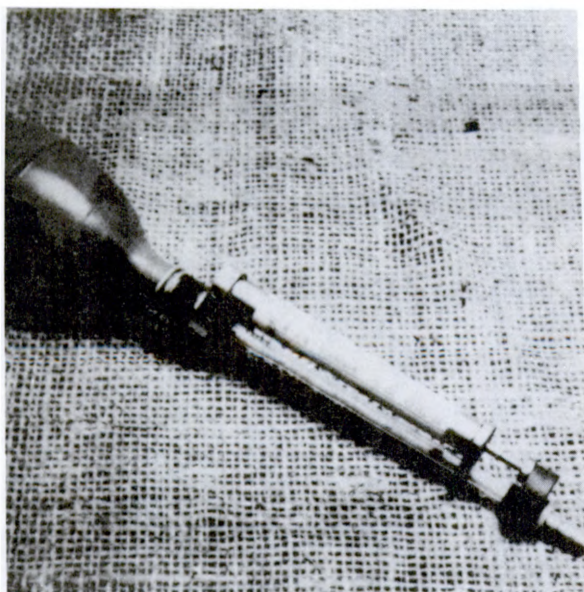


FIGURE 12C(1).
PORTABLE LENGTH-OF-STAIN
HYDROGEN SULFIDE DETECTOR

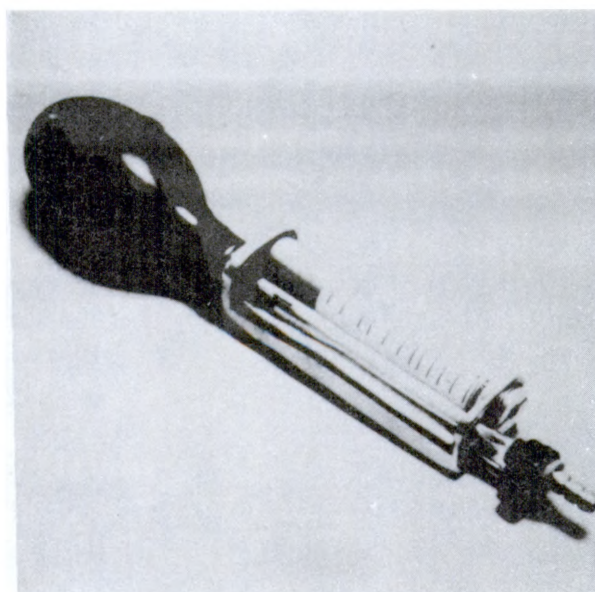


FIGURE 12C(2).
NITROGEN DIOXIDE DETECTOR

Each of these instruments is suitable for use at concentrations below, as well as above the TLV for a specific contaminant gas. However, the chemicals used in most of the detectors are sensitive and can react to more than one contaminant. This can cause confusion in correctly understanding test results.

FILL IN THE BLANKS

NITROGEN DIOXIDE CONCENTRATIONS BELOW THE TLV CAN BE MEASURED BY A _____ -
_____ - _____ INDICATOR.

Answer: length-of-stain

Various gases and vapors can also be detected by a single special instrument. The Scott Draeger Multi Gas Detector pictured in Figure 13C is not limited to measuring just one or two gases, but can be used to detect and measure more than 97 different gases and vapors by means of special detector tubes.

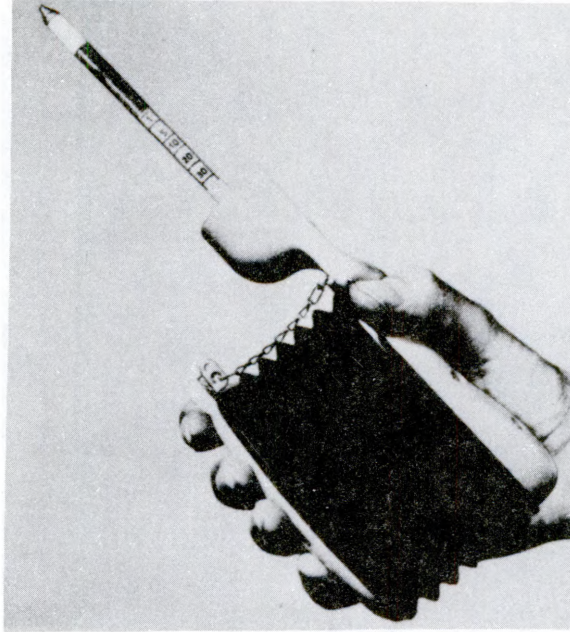


FIGURE 13C. DRAEGER MULTI-GAS DETECTOR

A harmful gas is indicated by a stain or color change of the chemicals in the tube. The color change that occurs, progressively increases in length as the concentration of the gas increases, indicating the result of the test without the need of a chart or graph.

TRUE OR FALSE

DUE TO THE SMALL NUMBER OF DIFFERENT GASES THAT A MULTI-GAS DETECTOR CAN MEASURE, IT IS NOT USUALLY USED TO GIVE ACCURATE MEASUREMENTS IN SHORT PERIODS OF TIME. _____

Answer: False

Other multi-gas detectors are also available such as the one pictured in Figure 14C.

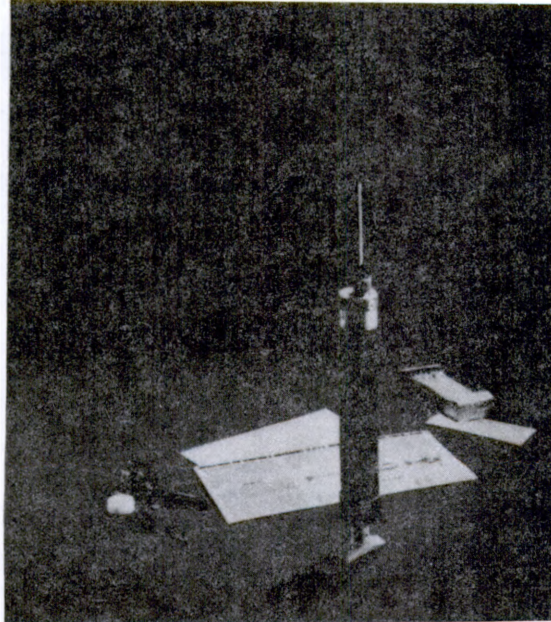


FIGURE 14C. MULTI-GAS DETECTOR

This particular instrument consists of a piston pump, various accessories, filter, tubes, etc. It is capable of handling sampling that at one time required as many as 16 separate detectors.

TRUE OR FALSE

MULTI-GAS DETECTORS HAVE SIMPLIFIED THE SAMPLING PROCESS. _____

Answer: True

All color change and length-of-stain instruments, however, do have some limitations. Differences in manufacturing processes and conditions cause variations in the tubes. Also, the accuracy of many of the tubes is affected by temperature extremes.

The biggest problem with these indicator tubes is interfering gases and vapors which cause poor test results. This places an added burden on the person who is interpreting the results. These tubes are also affected by the rate of air flow and also the amount of air drawn through the tube. Experience, therefore, is an important factor in getting accurate results based on these variables.

However, no matter what type of instrument is used, the final step in evaluating a hazard is deciding what the results of the samples obtained really say about a certain condition.

CIRCLE THE CORRECT ANSWER

THE MAJOR PROBLEM WITH INDICATOR TUBES IS

- A. MANUFACTURING CONDITIONS
- B. INTERFERING GASES AND VAPORS
- C. TEMPERATURE EXTREMES
- D. RATE OF AIR FLOW

Answer: B

34C

Let's pause and review what has been covered to this point in Section C concerning the evaluation and measurement of health hazards.

1. THE PROCESS OF MAKING A DECISION CONCERNING THE DEGREE OR AMOUNT OF A HAZARD IS TERMED _____.
2. AN AVERAGE EXPOSURE LEVEL DETERMINED BY SAMPLING AT CERTAIN TIMES DURING A WORKER'S EXPOSURE TO A SUBSTANCE IS CALLED OBTAINING A _____.
3. TRUE/FALSE - SAMPLING INSTRUMENTS ARE ATTACHED TO THE WORKER FOR THE PURPOSE OF PERIODIC EVALUATION DURING A PARTICULAR WORKING DAY. _____
4. TRUE/FALSE - INSTRUMENTS USED TO MEASURE CHEMICAL SUBSTANCES ARE SELECTED BASED ON WHETHER THE SUBSTANCE IS A PARTICULATE, GAS, OR VAPOR, WITH GASES AND VAPORS BEING THE EASIEST TO MEASURE. _____
5. PHYSICAL HAZARDS ARE MEASURED BY _____ INSTRUMENTS.

6. DIRECT-READING INSTRUMENTS USED FOR EVALUATION CAN BASICALLY BE EITHER _____ DIRECT-READING INSTRUMENTS OR _____ AND _____ INSTRUMENTS.
7. COMBUSTIBLE GAS INDICATORS AND SOUND LEVEL METERS ARE EXAMPLES OF _____ INSTRUMENTS.
8. TRUE/FALSE - DUE TO VARIOUS FACTORS AFFECTING THE ACCURACY OF ELECTRICAL DIRECT-READING INSTRUMENTS, FREQUENT MAINTENANCE AND CALIBRATION IS NECESSARY TO INSURE GREATER SUCCESS IN EVALUATION FINDINGS. _____
9. CARBON MONOXIDE, OXIDES OF NITROGEN, SULFUR DIOXIDE, AND HYDROGEN SULFIDE ARE GASES THAT ARE MEASURED BY _____ OR _____ INSTRUMENTS.
10. TRUE/FALSE - MULTI-GAS DETECTORS ARE DESIGNED JUST TO MEASURE ONE OR TWO SPECIFIC GASES. _____
-

- Answers:
1. evaluation
 2. time weighted average
 3. False
 4. True
 5. direct-reading
 6. electrical, color change, stain-length
 7. electrical direct-reading
 8. True
 9. color change, length-of-stain
 10. False

If the correct answers to the review questions were not clear, review before moving ahead.

The next part of Section C will deal with the Control of Health Hazards.

Prevention and Control

The evaluation process determines the effectiveness of controls that are used to reduce environmental stress to levels that you can put up with without damage to your health and well-being.

The prevention and control of health hazards is everybody's responsibility. You must follow established rules and safety procedures. This means reporting and correcting dangerous situations right away. It also means wearing personal protective gear when required. Any accidental exposure of a worker to dangerous substances must be immediately reported. If the report is delayed, those exposed may suffer needlessly. Both management and employees must work together to obtain a truly healthful work environment.

FILL IN THE BLANKS

EVERYBODY HAS THE RESPONSIBILITY TO _____ AND _____ HEALTH HAZARDS.

Answer: prevent, control

The best way to protect workers from hazards is to act before anyone is hurt. Several methods may be used to control hazards. Substitution of a less dangerous agent can eliminate or reduce a hazard. Dangerous operations can be isolated by being enclosed or they can be removed to special areas. Wet methods keep dust from polluting the air. Many atmospheric pollutants can be removed by local exhaust ventilation or diluted by general ventilation. Good housekeeping keeps wastes and dusts under control. Also, personal protective equipment should be used when the environment can't be made completely safe. The following is a complete list indicating the various methods for controlling environmental stress factors:

- Substitution of a less harmful material for one which is dangerous to your health.
- Change or alteration of a process to minimize worker contact.
- Isolation or enclosure of a process or work operation in order to reduce the number of persons exposed.
- Employment of wet methods to reduce generation of dust in operations such as mining and quarrying.

- Local exhaust ventilation at the point of generation or dispersion of contaminants.
- Minimizing the exposure time to maintain worker exposure at a safe level through administrative controls.
- General or dilution ventilation with clean air to provide a safe atmosphere.
- Personal protective devices, such as special clothing, ear, eye, and respiratory protection.
- Good housekeeping, including cleanliness of the workplace, waste disposal, adequate washing, toilet, and eating facilities, healthful drinking water, and control of insects and rodents.
- Medical controls.
- Training and education.

TRUE OR FALSE

IN ORDER TO BEST PROTECT A WORKER FROM A HAZARD, CORRECTIVE ACTION SHOULD BE TAKEN ONLY AFTER A PERSON HAS BEEN HURT. _____

Answer: False

It is important to look at each of these methods of control in more detail. First let's look at substitution.

It just makes sense to replace a toxic material with a harmless one, that is, substituting a less harmful substance for one that is dangerous to your health. This serves to help eliminate industrial health hazards. For example, the solvent trichloroethylene could be used in place of carbon tetrachloride.

In addition, less dangerous situations can also be substituted. An example of this would be evaluating welds without radiation. Substitution is indeed one of the most effective ways to decrease danger.

FILL IN THE BLANKS

ONE OF THE MOST EFFECTIVE WAYS OF DECREASING INDUSTRIAL HAZARDS IS _____.

 Answer: substitution

38C

Worker contact can be minimized by changing certain work processes for other less dangerous ones. To reduce ergonomic stress, easily operated and comfortable equipment can be substituted for outdated, awkward equipment. Also, if the cleaning of contaminated clothing or equipment can be done by machines instead of by hand washing, the health and safety hazard decreases.

An ideal chance to improve working conditions is often presented when there is a change in process. Of course, most of these changes are made to improve the quality or to reduce the cost of production; only occasionally are changes made to improve the environment in the plant. However, we must never lose sight of this possible benefit.

TRUE OR FALSE

A CHANGE OR MODIFICATION OF A PROCESS TO ELIMINATE A HEALTH HAZARD IS ALWAYS A GUARANTEE OF IMPROVING INDUSTRIAL HYGIENE CONDITIONS. _____

 Answer: False

39C

Exposure problems can sometimes be solved by isolating some potentially dangerous operations from the workers nearby. Isolation can take many forms. It may be by a physical barrier (an acoustic box, for example) to contain the noise from a whining blower or a screaming rip saw. Isolation can also be accomplished by time, such as providing semi-automatic equipment so that a worker does not have to constantly remain near the noisy machine. Finally, distance and remote controls can provide isolation.

Since an enclosure will prevent or minimize the escape of harmful substances into the workroom atmosphere, enclosing the process or equipment is a desirable method of isolation and control. After considering substitution for some of the more highly harmful substances or situations, enclosure should be one of the first measures attempted.

FILL IN THE BLANKS

THREE ALTERNATIVES BY WHICH INDIVIDUALS MAY BE ISOLATED FROM POTENTIALLY DANGEROUS OPERATIONS ARE _____, _____, AND _____. SEVERE HAZARDS PRESENTED BY DUST OR FUMES ARE FREQUENTLY BEST SOLVED BY _____.

Answer: physical barriers, time, distance; complete enclosure

40C

Wetting dust often keeps it from polluting the air. The application of water or other suitable liquid at the source of dust can often minimize or greatly reduce dust hazards. This method is frequently used for silica, coal, and loose dusts.

Wetting down is one of the simplest methods of controlling dust. Figure 15C illustrates the wetting method.

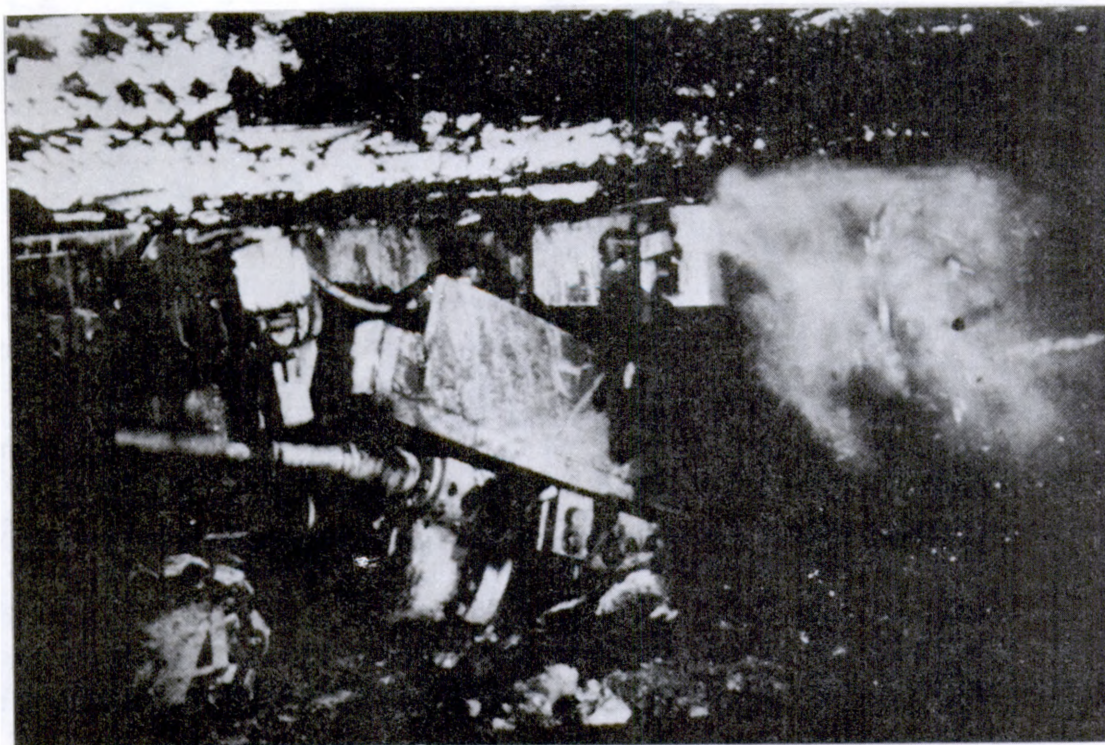


FIGURE 15C. USING WATER FOR WETTING DUST

The proper wetting of the dust, however, determines its effectiveness. The addition of a wetting agent to the water may be required. Also, proper disposal of the wetted dust is needed before it dries out and is redispersed. Water under high pressure is used successfully during mining of the ore face. By forcing water through the drill bits used in rock drilling operations, tremendous reductions in dust concentrations have been achieved.

FILL IN THE BLANKS

IN ORDER THAT WETTING DUST IS EFFECTIVE AS A METHOD OF CONTROL, ADDITION OF A _____ AND PROPER _____ OF WETTED DUST MIGHT BE REQUIRED.

Answer: wetting agent, disposal

Limited operations which require relatively few workers or where control by any other method is too difficult or too expensive may benefit by ventilation.

These workers could be protected from dust, for example, by local exhaust ventilation. This involves removing the dust at its source. Vacuum systems with funnel-type inlets suck in dust or other atmospheric contaminants where they are created. Mists, fumes, gases, vapors, and dusts can be controlled this way. The purpose of a local exhaust system is to trap the air contaminant near to its source so as to protect the worker from exposure to harmful concentrations.

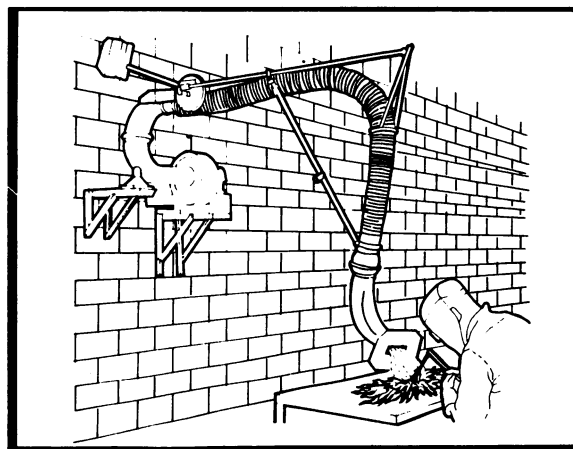


FIGURE 16C. LOCAL EXHAUST VENTILATION

FILL IN THE BLANKS

A METHOD OF DUST CONTROL IN WHICH VACUUM SYSTEMS SUCK CONTAMINANTS AWAY FROM SMALL WORK AREAS THROUGH VENTS IS _____.

 Answer: local exhaust ventilation

42C

Local exhaust vents are effective in keeping down the amount of air pollutants. This technique may be especially useful at grinding wheels, where mineral dust presents a danger. This is also true with spray painting, when inhalation of the chemical mist may cause illness. Local exhausts are most effective when the source of the contaminant is in a small, limited area. For example, in a laboratory chemicals are often stored under a hood, and an exhaust fan runs whenever the chemicals are in use.

FILL IN THE BLANKS

LOCAL EXHAUST IS MOST EFFECTIVE WHEN THE SOURCE OF THE CONTAMINANT IS IN A _____.

 Answer: limited area

43C

When the source of the air pollutant covers too large an area, local exhaust is not practical. General or dilution ventilation may then be used. In this system, fresh air (which may be temperature- and humidity-controlled) is fed in large amounts into the work area. The polluted air is then drawn out through exit vents, windows, or doors. There must be enough space and air movement so that the pollutant is diluted before it reaches the workers.

The purpose of a general or dilution ventilation system is to distribute fresh air at a comfortable temperature and humidity throughout a working area. Since it relies on fresh air to merely dilute harmful substances, a general ventilation system is not usually the most effective method of controlling hazards.

FILL IN THE BLANKS

WHEN THE SOURCE OF THE CONTAMINANT IS SPREAD OVER A LARGE AREA, _____ VENTILATION IS OFTEN USED. FOR THIS METHOD TO WORK, THERE MUST BE ENOUGH SPACE SO THAT THE POLLUTANT IS _____ BEFORE IT REACHES THE WORKER.

 Answer: general; diluted

44C

There are several principles of good practice for general ventilation systems:

- Fresh air coming into the work area should circulate through worker-inhabited areas (such as the working face of a coal mine) where there are harmful substances, in order that the workers be able to breathe air that is as uncontaminated as possible.
- Cross drafts should be avoided by distributing air evenly throughout the work area (such as using brattice curtains in coal mining).
- The inlet of the general ventilation system should be located well away from the exhaust system outlet and other sources of contaminated air.
- Air should be treated--that is, heated, cooled, humidified, or de-humidified--so as to maintain a comfortable and healthful atmosphere for the workers (such as in deep metal/nonmetal underground mines).

45C

Occasionally it may be possible to reduce a worker's exposure to hazards by limiting the amount of time spent in the hazardous area. The reduction of the amount of time actually engaged in work activity can be an effective control of hazardous work conditions. This is a type of administrative control. By limiting the exposure time, it is possible to maintain the total exposure to less than what is allowed by the threshold limit values. For example, limiting the amount of exposure time to noise levels in excess of 90 dBA may serve to keep the daily exposure below the allowable limit.

Rest periods are also useful in reducing effects of exposure to hazardous conditions. For example, conditions of high temperature and humidity have adverse effects on the human body and can produce heat stress problems.

Rest periods allow the body time to recover from these stressful conditions. Administrative controls should only be used in conjunction with other control procedures mentioned in this section.

FILL IN THE BLANK

CONTROLS USED TO REDUCE THE AMOUNT OF EXPOSURE TO HAZARDOUS CONDITIONS BY LIMITING THE EXPOSURE TIME ARE CALLED _____ CONTROLS.

Answer: administrative

In addition to changing the environment to eliminate or reduce hazards, dangerous situations can be reduced by good housekeeping. If dust on the floor and shelves is vacuumed away regularly, it won't move into the atmosphere and be inhaled or have a chance to irritate the skin. Cleaning equipment reduces breakdowns and malfunctions which may physically hurt you or cause financial damage to the company. Spills, splatters, and overflows when not cleaned up right away can lead to slips and falls. Hazardous wastes and trash must not be allowed to pile up and create a hazard. In addition, all materials used and produced should be stored properly for the same reason. Also, insects and rodents carry disease and should be controlled.

FILL IN THE BLANKS

CLEANING UP SPILLS AND SPLATTERS, VACUUMING DUST IN THE WORK AREA, TAKING CARE OF WASTES AND TRASH, AND STORING ALL MATERIALS USED AND PRODUCED ARE EXAMPLES OF _____.

Answer: good housekeeping

Personal hygiene habits are also important. With this in mind, adequate washing, toilet, and eating facilities as well as sanitary drinking water should be provided. In addition, if your clothes or body get dirty, or if you work with chemicals, you should shower and change clothes before leaving work. Contaminated work clothes and clean street clothes should be kept in separate lockers. These precautions assure that your skin will not be exposed to irritating contaminants after work. To protect others (like your family), contaminated clothing should not be taken home. Good housekeeping is an important part of an occupational health program. It is another tool that is used for preventing the spread of dangerous contaminants.

TRUE OR FALSE

CORRECT PERSONAL HYGIENE HABITS PROTECT YOU, AS WELL AS OTHERS WHO ASSOCIATE WITH YOU. _____

Answer: True

48C

Personal protective equipment gives further protection when the environment cannot be made totally safe. Its biggest drawback is that it doesn't eliminate or reduce the hazard. Its failure means immediate exposure to danger. In some cases, the protective device may stop functioning without your realizing it.

There are different protective devices for each job and for many different parts of the body. All applicable safety devices should be worn on the job at all times. However, personal protective equipment should be employed only as a secondary alternative, after the other controls which we have mentioned have been ruled out.

FILL IN THE BLANKS

THE BIGGEST DISADVANTAGE OF PERSONAL PROTECTIVE EQUIPMENT IS THAT IT DOES NOT _____ OR _____ THE HAZARD.

Answer: eliminate, reduce

49C

Personal protective equipment includes such things as gloves, aprons, boots, overalls, goggles, hard hats, ear protectors, and respirators. What equipment is worn depends on the hazards of each particular job.

The eyes need goggles or safety glasses for protection from flying objects, massive blows, and chemical burns. Special goggles are designed to keep out chemical splashes and atmospheric pollutants that filter out ultraviolet and infrared light. Face shields are used to protect the face from harmful substances and foreign objects. There are numerous eye and face protection devices available.

Figure 17C pictures some of the face and eye shields available for use.



FIGURE 17C. EYE AND FACE SHIELDS

The most important point to remember, however, is that if these eye and face shields are not comfortable, they will not be worn, even when they are needed or required.

FILL IN THE BLANK

ALTHOUGH THERE ARE MANY EYE AND FACE SHIELDS AVAILABLE, _____ IS THE KEY TO WHETHER OR NOT THEY ARE WORN.

Answer: comfort

Ideally, noise should be reduced or controlled at the source of its production. However, this is not always possible. Therefore, various controls may be required to conserve hearing. Examples of personal protective equipment for the ears are large earmuffs, sound shields, or ear plugs like those pictured in Figure 18C.



FIGURE 18C. EAR PROTECTION

Muffs offer the best personal protection against loud noise. Fitting them for a person is not a problem and they can easily be adjusted. Some workers, however, say muffs are uncomfortable and many types cannot be worn with safety hats or welding shields.

Ear plugs, on the other hand, are more comfortable if fitted properly. However, they do not offer as much protection and are only recommended for use in an area of moderate noise levels. Drawbacks to their use, according to many workers, is that initially they have to be fitted by a medical expert and then properly inserted each day by the employee for the best effectiveness and comfort. Also, aside from the fact ear protectors can be uncomfortable, many workers do not feel they need protection because hearing loss is gradual and goes unnoticed. They also need to be cleaned daily to prevent ear infections.

FILL IN THE BLANKS

THE TYPE OF PERSONAL PROTECTIVE EQUIPMENT THAT OFFERS THE BEST RESULT AGAINST LOUD NOISE IS THE _____, WHEREAS _____ ARE USED FOR PROTECTION AGAINST MODERATE NOISE.

 Answer: muffs, plugs

Environmental controls are more effective than protective clothing or protective creams and they do not depend on the worker for success. However, in situations where there is prolonged or repeated contact with dermatitis-producing solvents, chemicals, or dust, protective clothing should be worn to control the hazards. Such clothing includes gloves, aprons, boots, coveralls, and other items. The proper protective article should be selected for the specific situation. As an example, some types of rubber will withstand the solvent trichloroethylene, but will become spongy and disintegrate when exposed to a lacquer solvent.

Selection of the proper protective article is important. If the harmful, irritating substance is in dry form, cotton gloves and clothing that can be laundered easily will do the job. If the irritating substance is liquid, clothing that the liquid cannot penetrate should be chosen. Again, these articles should be laundered frequently.

Reflective, aluminized clothing can be used for intermittent protection against radiant heat. Special care must be given to such garments so as to preserve the shiny surface which is the essential part of protection for you. High heat loads can be made bearable by use of air-cooled jackets and suits while protection against ionizing radiation is available in the form of lead-bearing materials.

Also, hard hats need to be worn in most industries. A hard hat protects your head against massive blows from swinging equipment, falling objects, and numerous other hazards. Steel-toed boots that prevent feet from being crushed are also a necessity in most industries.

FILL IN THE BLANK

THE SUCCESS OF PROTECTIVE CLOTHING DEPENDS ON THE _____ USING THEM AND HOW THEY ARE USED.

 Answer: worker

Protective creams, although their effectiveness varies, help reduce skin contact simply from the necessity of having to wash them off. When this occurs, the contaminant on the skin is washed away. These creams protect against such things as dust, water soluble materials, oil, and solvents. They should be used when other protective equipment is not suited for a particular climate, in situations where manual dexterity is required and bulky clothing hinders the work process, and where certain clothing creates a safety hazard near moving machinery.

FILL IN THE BLANK

ALTHOUGH PROTECTIVE CREAMS PROTECT AGAINST DUST, WATER SOLUBLE MATERIALS, OIL, AND SOLVENTS, THEIR REAL ACCOMPLISHMENT IN DOING THE JOB OF CONTROL COMES WHEN THEY ARE _____ FROM THE SKIN ALONG WITH THE CONTAMINANT.

 Answer: washed

One of the major hazards found in a coal mine is coal dust. There may also be other dusts, such as silica and other rock dusts. In addition, mists from paint sprays and other toxic dusts, mists, and fumes may be encountered.

In those cases where dusts, gases, and other pollutants in the air cannot be controlled, gas masks or respirators may be necessary. When you inhale through a gas mask, the air is drawn through chemicals contained in the canister, and they remove harmful gases from the air. Gas masks should be used if the eyes must be protected or if high concentrations of gases or vapors are probable. Since gas masks supply no oxygen, there must be sufficient oxygen in the atmosphere.

FILL IN THE BLANKS

55C

IF DUST AND OTHER AIR POLLUTANTS CANNOT BE CONTROLLED, THE USE OF _____
OR _____ CAN PROVIDE PROTECTION. FOR A GAS MASK TO
BE EFFECTIVE, THERE MUST BE _____ IN THE AIR.

Answer: gas masks, respirators; sufficient oxygen

56C

A respirator is a device which fits over the mouth and nose and prevents dust from being inhaled into the throat and lungs.

There are two basic types of respirators used in the mines: the supplied-air and the filter-type.

Supplied-air respirators are devices which provide the wearer with an independent supply of clean air. This air may be supplied through a small air line (hose) from an air compressor or from compressed air cylinders. If you have to wear a supplied-air respirator, you will receive special training on how to use it. Figure 19C illustrates a supplied-air respirator.



FIGURE 19C. SUPPLIED-AIR TYPE RESPIRATOR

TRUE OR FALSE

SUPPLIED-AIR RESPIRATORS ARE USED MAINLY WHEN THERE IS A LOT OF DUST IN THE WORK AREA. _____

Answer: false

The filter-type, or air-purifying, respirator is the type most commonly used in the mine. These respirators use a filtering system which cleans the air before it is inhaled so that the wearer breathes clean, non-contaminated air. An example would be an air-purifying respirator such as a gas mask.

There are two kinds of filter-type respirators. One is a chemical cartridge type, which is designed to remove only certain dangerous gases and vapors. An example of this type is your self-rescuer, which protects you from carbon monoxide. The other is the particulate filter type, which removes dust, mist, fumes, and sprays from the air.

The type of respirator used depends on the type of contaminant in the area. Figure 20C illustrates the various filter-type respirators.

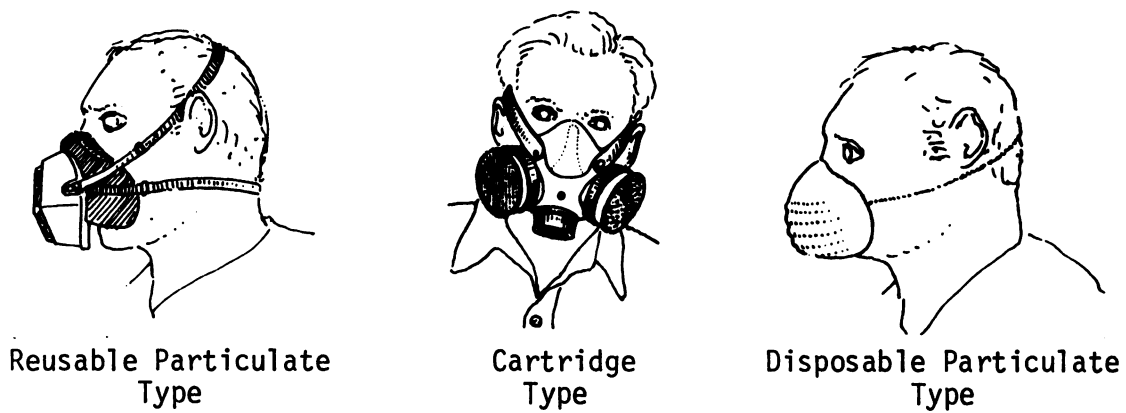


FIGURE 20C. FILTER-TYPE RESPIRATORS

CIRCLE THE CORRECT ANSWER

IF YOUR JOB IS DRILLING, THE TYPE OF RESPIRATOR YOU SHOULD WEAR IS

- A. SUPPLIED-AIR
- B. PARTICULATE FILTER
- C. SELF-RESCUER
- D. CHEMICAL CARTRIDGE TYPE RESPIRATOR

Answer: A or B

The particulate filter type respirators work much like the air filter on a car, furnace, or air conditioner.

Air can pass through a filter, but other things cannot. The filter catches the other things and prevents them from passing through. When you wear a respirator, you breathe the contaminated air into the respirator filter. Here a porous material traps the contaminant but allows air to pass through and the clean air to enter your lungs.

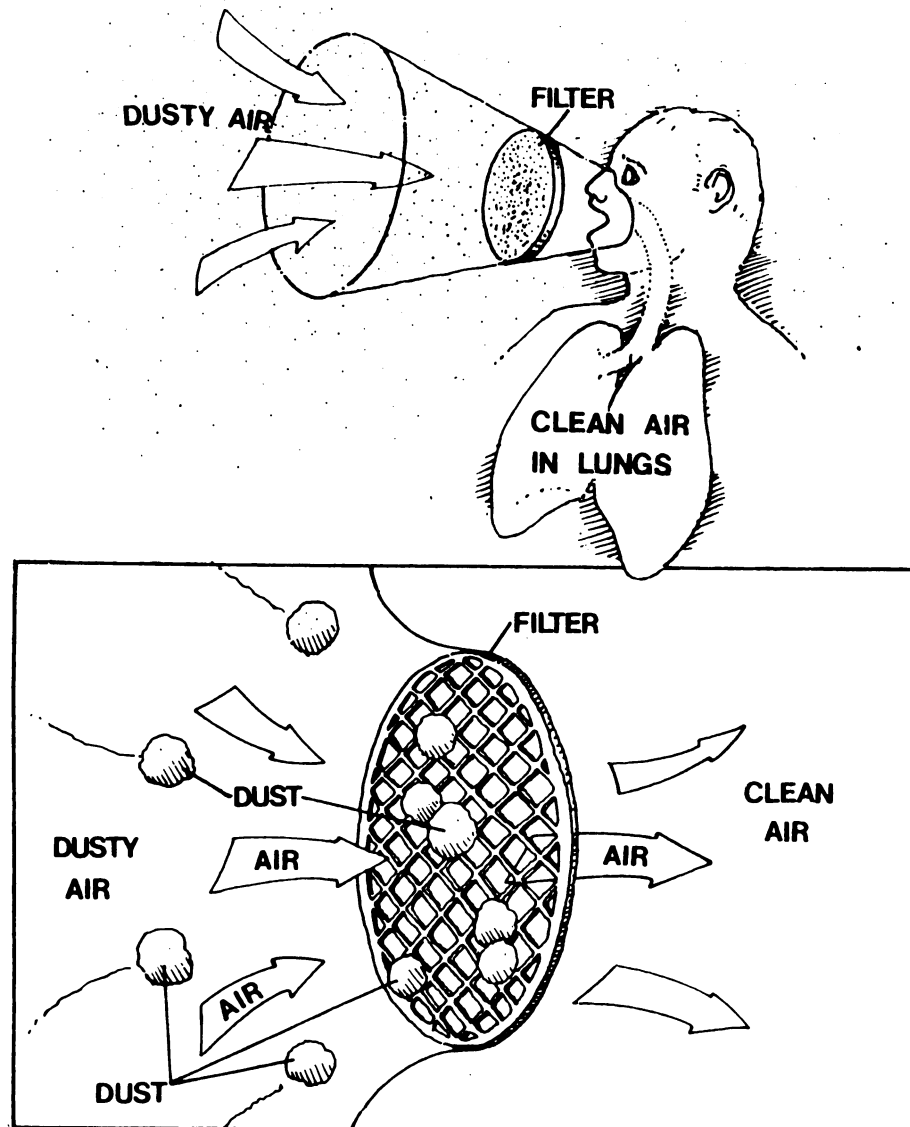


FIGURE 21C. HOW A RESPIRATOR WORKS

CIRCLE THE CORRECT ANSWER

THE PARTICULATE RESPIRATOR REMOVES DUST FROM THE AIR BY

- A. A CHEMICAL REACTION
- B. PROVIDING OXYGEN
- C. FILTERING OUT CONTAMINANTS
- D. BOTH A AND C

Answer: C

59C

The effectiveness of a particulate respirator is limited by the amount of dust in the air and the type of work you are doing. A filter can only hold so much dust before it becomes clogged. So if you are in a very dusty area or if you are breathing hard, you will pull more dust into the filter and clog it faster than if there is little dust or you are breathing easily.

The effectiveness of this respirator also depends on the tightness of the seal between the facepiece and your face. If it does not seal tightly, dusty air can leak in. Poor face seals can be caused by beards, long sideburns, chewing or talking, and missing dentures. Since you must remove the respirator to spit, you should not chew tobacco while wearing one.

CIRCLE THE CORRECT ANSWER

BECAUSE THE EFFECTIVENESS OF A RESPIRATOR DEPENDS ON THE TIGHTNESS OF THE SEAL BETWEEN THE FACEPIECE AND YOUR FACE, YOU SHOULD BE AWARE OF POOR FACE SEALS THAT CAN BE CAUSED BY

- A. UNUSUAL FACIAL FEATURES
- B. BEARDS AND LONG SIDEBURNS
- C. DIRTY FILTERS
- D. NOT BITING DOWN ON THE MOUTHPIECE

Answer: A and B

A limitation of any respirator, however, is that it hinders communication. Communication is difficult because the respirator interferes with the sound of your voice. Communicating can break the face seal, so you should talk as little as possible.

Because respirators as well as gas masks make talking difficult, a system of hand and head movements should be arranged for communication, since communication with others is a vital safety precaution. Whether using breathing aids or not, telling others where you are going and how long you will be gone is a good safety habit. If you get into trouble and cannot signal for help, someone will begin to check for you when you do not return on time. Also, equipment operators will know where to expect you if they must work or travel near you.

FILL IN THE BLANK

THE FACT THAT RESPIRATORS MAKE TALKING DIFFICULT INDICATES A NEED FOR AN ALTERNATE METHOD OF _____ AS A VITAL SAFETY PRECAUTION.

Answer: communication

61C

The most important limitation, however, is that the particulate respirator should be used only to protect you against dusts, mists, and sprays. It does not protect you against carbon monoxide, methane, or other harmful gases often found in the mine. Also, it is not a substitute for a supplied-air respirator or self-contained breathing apparatus and must not be used for protection while fighting fires.

62C

Some people do not like to wear respirators. They say that they make it hard to breathe, that they are warm and uncomfortable, or that they make eye glasses hard to wear. It is important to remember that a respirator protects you. Anything on your face may feel warm and uncomfortable, but you can minimize the discomfort by adjusting the mask properly. Forcing the air through a filter when you breathe may make it more difficult to breathe. However, after a few minutes it should no longer be noticeable. If you wear glasses, you need to get a respirator that fits properly with your glasses on. Remember, change the filter when it becomes clogged. This will help make it easier to breathe through the respirator. If used and maintained properly, respirators can and do protect your health.

TRUE OR FALSE

IN WORK ENVIRONMENTS WHERE HARMFUL GAS IS FOUND, PARTICULATE RESPIRATORS CAN BE SUBSTITUTED FOR A SUPPLIED-AIR RESPIRATOR. _____

Answer: False

The proper type of respiratory protective equipment should be selected according to the following procedures:

1. Identify the substance or substances against which protection is required.
2. Know the hazards of each substance and its significant characteristics.
3. Determine the levels of air contamination, oxygen deficiency, and the conditions of exposure.
4. Determine if there are any personal capabilities and characteristics essential to the safe use of the required devices or procedures.
5. Determine what facilities are needed for maintenance of the respirator.

CIRCLE THE CORRECT ANSWER

SELECTION OF THE PROPER TYPE OF RESPIRATORY PROTECTIVE EQUIPMENT IS BASED ON WHICH OF THE FOLLOWING:

- A. THE TYPE OF SUBSTANCE AGAINST WHICH PROTECTION IS REQUIRED.
- B. THE LEVELS OF AIR CONTAMINATION, OXYGEN DEFICIENCY, AND CONDITIONS OF EXPOSURE.
- C. THE HAZARDS AND SIGNIFICANT PROPERTIES OF THE SUBSTANCE AGAINST WHICH PROTECTION IS REQUIRED.
- D. ALL OF THE ABOVE.
- E. NONE OF THE ABOVE

Answer: D

An effective medical program can also help control and prevent certain health hazards. These medical programs essentially serve as a check on established controls by helping to identify control failures that must be corrected. Routine physical exams after an initial preemployment physical will check employees exposed to harmful materials for possible disease signs.

TRUE OR FALSE

EFFECTIVE MEDICAL CONTROL PROGRAMS WILL ONLY HELP PREVENT CASES OF OCCUPATIONAL DISEASE. _____

Answer: True

However, a main method of control and your main protection against these assorted hazards is just knowing about them. Through education and training you can recognize, report, and avoid them. To gain the most benefit, you must constantly be receptive to new information as it develops, and be able to apply the information you have learned. Although this course outlines some general precautions and controls, specific instructions and considerations are needed for each situation. You must understand why safety measures need to be taken and what will happen if they are not.

FILL IN THE BLANKS

YOUR MOST IMPORTANT DEFENSE AGAINST INDUSTRIAL HAZARDS IS _____ AND _____.

Answer: education, training

Application of Controls

All of these methods of hazard prevention and control apply to different situations. Some examples can be used to examine how all or several of the previously mentioned preventive measures can be applied. For example, flammable liquid hazards, like those with solvents, can be controlled in various ways. These hazards are often overlooked, perhaps because the use of flammable liquids is so common. The dangerous situation arises when the liquid evaporates into the air and forms an explosive vapor. Nearby sources of ignition such as open flames, hot surfaces, and sparks from the operation of electrical equipment or discharges of static electricity may be enough to ignite the air-vapor mixture.

One technique used to eliminate this hazard is the substitution of a less dangerous liquid for the flammable one. Proper storage, handling, and dispensing limit the danger when flammable or explosive substances must be used. Reducing the amount of the liquid will also reduce the hazard because less vapor will form. Vapors can also be controlled by being enclosed, removed by local exhaust ventilation, or diluted by general ventilation. Special waste containers for soaked solid waste should be available and emptied frequently. Liquids, too, must be properly disposed of, not just poured down the drain. Figure 22C pictures a portable safety can used for the storage of flammable liquids.

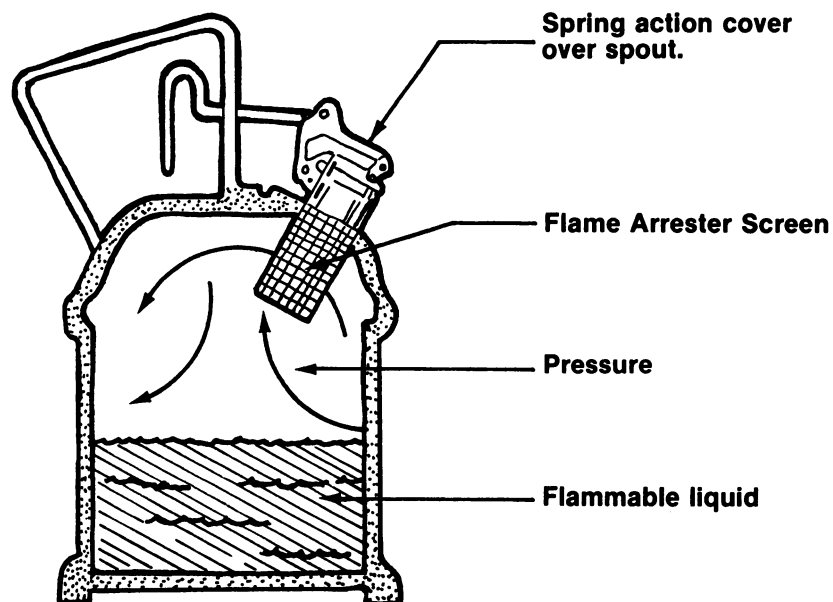


FIGURE 22C. PORTABLE SAFETY CAN

CIRCLE THE CORRECT ANSWER

WHICH OF THE FOLLOWING CAN BE PROPER METHODS OF CONTROLLING FLAMMABLE LIQUIDS?

- A. SUBSTITUTION
- B. ENCLOSURE
- C. VENTILATION
- D. PROPER STORAGE, HANDLING, AND DISPOSAL
- E. ALL THE ABOVE

 Answer: E

When it comes to dermatitis, the best method of control is to avoid skin contact. This is hard to do, however, the places you work should be designed to assure minimal contact. Another good dermatitis control measure is for you the employee to become educated and informed about any harmful material that is required to be used.

Personal protective equipment such as gloves, boots, and shoes should be used as a secondary defense against dermatitis. Also, this personal protective equipment must be in good repair and clean to be effective. Protective creams, although they provide only limited protection against dermatitis, benefit the worker mainly from having to wash the cream off.

COMPLETE THE FOLLOWING SENTENCE

THE PRIMARY DEFENSE AGAINST DERMATITIS IS _____.

Answer: to avoid skin contact

In the mining industry, epoxy resin is used frequently in roof bolting. These epoxy resins can be a mild to strong skin irritant depending on the person exposed. However, some of the most severe exposures comes from direct contact with the hardener. To prevent dermatitis from epoxy resins, the following control measures can be helpful:

- Select hardeners that have the least irritating effect.
- Use just as much hardener as necessary.
- Provide adequate local exhaust ventilation.
- Minimize handling.
- Separate the work area.
- Educate the worker about the hazard.
- Use specific personal protective equipment.
- Insist on good personal cleanliness.
- Avoid touching face or other skin with anything that is contaminated.
- Use good housekeeping.

FILL IN THE BLANK

SOME OF THE MOST SEVERE DERMATITIS REACTIONS WITH EPOXY RESIN COMES FROM CONTACT WITH THE _____.

Answer: hardener

Gases, dust, mist, and fumes also need to be controlled. Dust, mist, and fumes should, when possible, be controlled at their source of production. When this type of control is not possible, then other desired control methods such as the following are needed to limit exposure:

- Enclosure
- Isolation
- Substitution of less hazardous material
- Keep materials moist
- Local exhaust ventilation
- General ventilation
- Perform work when fewer people are around, reducing the number of workers exposed
- Reduce working time
- Use respiratory protective equipment

TRUE OR FALSE

GASES, DUST, MIST, AND FUMES ARE BEST CONTROLLED BY SUBSTITUTION. _____

Answer: False

Noise can also present a hazard, and as such needs to be controlled. Every noise problem consists of a source of sound and a path along which it travels as well as a receiver for the sound.

Controlling noise at the source is a design problem. Noise control along the path of sound is accomplished by shielding, enclosure, or distance. However, noise control methods include:

- isolation
- machine insulation
- absorption material on the walls
- substitution of less noisy equipment
- reduction of exposure time
- personal protection equipment

TRUE OR FALSE

NOISE CAN BE CONTROLLED AT ITS SOURCE, PATH, AND THE PLACE OF RECEPTION.

Answer: True

Because a worker in the mines is more likely to suffer heat stress than cold stress, control of excessive heat is important. Heat can be controlled by shielding hot equipment, increasing air movement and the supply of fresh air, acclimatization of the worker, isolation of the source of heat if possible, and through the use of protective clothing. Of all these control methods, personal acclimatization is perhaps the most important. Acclimatization allows a person to do a hot job with less physical stress than a person who is not used to hot conditions.

FILL IN THE BLANK

OF ALL THE CONTROL METHODS FOR HEAT, _____ IS PERHAPS THE MOST EFFECTIVE MEANS OF CONTROL FOR THE WORKER.

Answer: acclimatization

Radiation is another hazard for which multiple precautions are needed. Especially since many of the effects are still unknown, great care must be taken to avoid any unnecessary exposure. Radioactive wastes must never be left unprotected. Systems using radioactive material must be properly maintained and isolated. All nearby workers must be shielded with the right kind and thickness of material. If the source of the radiation is a dust or gas, ventilation is needed to keep the work area safe. The ventilation system must be able to hold the radioactive waste until it can be disposed of in the right way.

The levels of radioactivity must be continually monitored to make sure they stay within the safe limits. In fact, the shorter the time of exposure, the smaller the radiation dose received. Also, the more shielding placed between radioactive material and a person the less radiation a person will receive. Distance between a person and a radiation source is also a key protection tool. In addition, radiation meters can be worn to monitor each worker's accumulated exposure to certain types of radiation. These precautions are the employer's responsibility, but if any advisable precautions are not taken, it's up to the worker to report the problem. Everyone's safety depends on it.

FILL IN THE BLANKS

PROTECTION FROM LARGE DOSES OF RADIATION ARE PROVIDED BY _____, _____, AND _____.

Answer: time, distance, shielding

Many ergonomic stresses can also be prevented or lessened. Some ergonomic stresses, such as worry, are difficult to eliminate but must still be taken into account. In addition it must be realized that ergonomic stresses will affect production and accident rates.

To reduce the ergonomic stress of fatigue, several things can be done. Your worktime and breaks should be arranged so they create the least fatigue. Each worker must be suited to his task, taught the best way to do the job, and above all follow work instructions.

The stress of monotony and boredom can be alleviated by arranging a periodical job switch. Also, back injuries, a common accident occurring in the industrial setting, can usually be avoided by lifting and carrying the right way. When lifting, keep your feet apart with one foot beside the object and one behind it. Keep your back straight up and down, and tuck in your arms. Grip the whole object, and lift it, keeping your weight directly over your feet.



FIGURE 23C. CORRECT LIFTING

Other injuries to the musculo-skeletal system caused by ergonomic stresses can be avoided if you use well-designed equipment and do not work in uncomfortable positions for extended time periods.

TRUE OR FALSE

SOME ERGONOMIC STRESSES (LIKE WORRY) ARE DIFFICULT TO ELIMINATE SO YOU MIGHT AS WELL FORGET ABOUT THEM. _____

Answer: False

Carcinogens are those substances that can be absorbed, swallowed, or inhaled that cause cancer. Because they exist in industry, workers must have some form of protection if they are exposed to an occupational carcinogen for any length of time. These carcinogens must be restricted to areas where exposure can be prevented and these areas should be identified by signs and warning labels. Also, because of the type of hazard, eating, drinking, storing food, and smoking should be banned in these areas.

Individuals that work around known cancer-causing substances should:

- Use required personal protective equipment.
- Wash and shower if required.
- Properly handle contaminated clothing and equipment.
- And be able to take emergency steps in case of accidental exposure.

FILL IN THE BLANKS

BECAUSE CARCINOGENS CAN BE SWALLOWED, ABSORBED, OR INHALED, INDIVIDUALS SHOULD NOT _____, _____, _____, OR STORE _____ IN AREAS WHERE CANCER-CAUSING SUBSTANCES EXIST.

Answer: eat, drink, smoke, food

Accidents and injuries happen even when all possible safety precautions are taken. Because of this, even if you are following safety rules and procedures, as well as good personal cleanliness habits, you must pay attention to any warnings your body might give you. Be sure to report any dangerous conditions to your supervisor. Accidental exposures to unsafe substances should be reported immediately. If you follow these guidelines, the chances of injury and illness are greatly reduced.

FILL IN THE BLANKS

YOUR MOST IMPORTANT DEFENSE AGAINST INDUSTRIAL HAZARDS IS _____ AND _____.

Answer: education, training

LET'S PAUSE AND REVIEW THE FINAL PART OF SECTION C WHICH DEALS WITH THE CONTROL OF HEALTH HAZARDS. PUT THE LETTER OF THE PROTECTIVE EQUIPMENT IN FRONT OF THE HAZARD IT PROTECTS YOU FROM (MORE THAN ONE LETTER MAY GO ON ONE LINE):

- | | |
|--|--|
| 1. _____ HANDLING CHEMICALS | A. GOGGLES OR SAFETY GLASSES |
| 2. _____ GAMMA AND X-RAYS | B. AIR-COOLED SUIT |
| 3. _____ HEAT | C. REFLECTIVE SUIT |
| 4. _____ WORKING WITH SOLVENTS | D. EARMUFFS OR PLUGS |
| 5. _____ HEARING LOSS | E. SUITS MADE OF LEAD-BEARING MATERIAL |
| 6. _____ MASSIVE BLOWS, FLYING OBJECTS, AND CHEMICAL BURNS TO THE EYES | F. GLOVES |
| 7. _____ BLOWS TO THE HEAD FROM SWINGING EQUIPMENT AND FALLING OBJECTS | G. BARRIER CREAMS |
| 8. _____ RESPIRABLE DUST OR GASES | H. STEEL-TOED BOOTS |
| 9. _____ ERGONOMIC STRESS | I. HARD HATS |
| | J. RESPIRATOR OR GAS MASK |
| | K. AVOID SKIN CONTACT |
| | L. ACCLIMATIZATION |
| | M. WELL-DESIGNED EQUIPMENT |
10. TRUE OR FALSE - THE PREVENTION AND CONTROL OF HEALTH HAZARDS IS THE WORKERS' RESPONSIBILITY. _____
11. ONE OF THE MOST EFFECTIVE WAYS OF DECREASING AN INDUSTRIAL HEALTH HAZARD IS BY
- A. CHANGING THE PROCESS
 - B. ISOLATION
 - C. SUBSTITUTION
 - D. VENTILATION
 - E. WETTING DOWN THE SUBSTANCE

12. THE REDUCTION OF TIME SPENT IN A HAZARDOUS AREA IS AN EFFECTIVE CONTROL MEASURE AND IS ACCOMPLISHED THROUGH _____.
13. ONE OF THE SIMPLEST METHODS OF CONTROLLING DUST IS BY _____.
14. THE TYPE OF VENTILATION THAT REMOVES A CONTAMINANT AT ITS SOURCE IS _____ WHILE _____ VENTILATION MERELY DILUTES THE AIR.
15. WHEN THE ENVIRONMENT CANNOT BE MADE SAFE USING OTHER CONTROLS, _____ CAN GIVE PROTECTION.

-
- Answers:
- 1. f, g, k
 - 2. e
 - 3. b, c, l
 - 4. f, g, k
 - 5. d
 - 6. a
 - 7. h, i
 - 8. j
 - 9. m
 - 10. false
 - 11. substitution
 - 12. administrative controls
 - 13. wetting down
 - 14. local exhaust, general
 - 15. personal protective equipment

If the correct answers to the review questions were not clear, review the last part of Section C before moving ahead. The final section of this course deals with the specific relationship of industrial hygiene to the mining industry.

INDUSTRIAL HYGIENE
FOR THE MINING INDUSTRY

SECTION D

"INDUSTRIAL HYGIENE AND MINING"

This is Section D, the final section in the Industrial Hygiene Programmed Instruction Course. The first three sections of the course provide a foundation of information concerning industrial hygiene. Also, various examples were used in the first three sections relating industrial hygiene to the mining industry. The final section of the course, however, will focus specifically on accidents and industrial hygiene health hazards found in the mining industry. Again, follow the same procedures in completing the final section of the course as you did in the first three sections.

Accidents

Accidents resulting in death or lost work time have typically been higher among young, new workers. In fact, accidents are the leading cause of death in the United States among young workers between 15 and 44 years of age. Figure 1D indicates the percentage of deaths caused by accidents in these age groups.

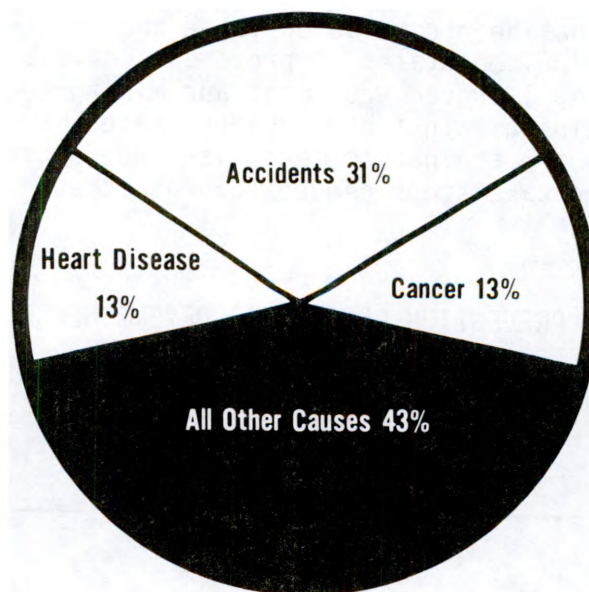


FIGURE 1D. ACCIDENT RATES

3D

Accidents usually result from one or more unsafe acts or unsafe conditions, or both. Because of this relationship, unsafe acts and conditions are identified as the indirect causes or symptoms. In turn, indirect causes are usually traceable to poor management policies and decisions, or to personal or environmental factors which are identified as basic causes.

FILL IN THE BLANK

ACCORDING TO STATISTICS, PERSONS 15 TO 44 ARE MOST LIKELY TO DIE FROM

_____.

Answer: accidents

4D

While most accidents are complex, many of them can be prevented by eliminating one or more of the causes. A successful accident prevention program, however, requires the complete support and cooperation of all employees — from top management to the individual worker.

Although mining has been considered to be one of the most hazardous of all industries in the United States, improvements have been made in recent years through research, improved equipment and mining techniques, inspections, and education and training. In fact, accident rates have decreased markedly in areas where miners are trained to recognize and control hazardous conditions, and are able to take steps needed to protect each other.

TRUE OR FALSE

A SUCCESSFUL ACCIDENT PREVENTION PROGRAM IS DETERMINED BY THE INDIVIDUAL WORKER. _____

Answer: false

5D

The fact that mining is a hazardous occupation is proven by the statistics which show that in 1984, 188 miners lost their lives. These figures include those from coal, metal, nonmetal, stone, as well as sand and gravel mines.

The following table shows the number of deaths that occurred in different types of mines.

<u>Coal</u>	<u>Metal</u>	<u>Nonmetal</u>
Underground - 96	Underground - 15	Underground - 2
Surface - 15	Surface - 4	Surface - 3
Prep Plant - 7	Mills - 3	Mills - 3
	<u>Stone</u>	<u>Sand/Gravel</u>
	Underground - 2	Surface - 11
	Surface - 14	
	Mills - 13	

As you can see, the majority of the fatalities happened in the underground areas of the mines. Not shown was the fact that falls of the roof, face, or rib, handling material, ignitions, transportation and haulage, and improper use or malfunction of machinery were the main causes of both injury and death.

As a result of accidents and deaths, laws have been passed to enforce safe practices in the mines. Federal responsibilities and duties pertaining to protection of the health and safety of America's miners currently are being carried out under provisions of the Federal Mine Safety and Health Act of 1977. Also, improved technology, special procedures, and protective devices have been developed to protect each miner. Regulations outline these procedures and make their use mandatory. These, along with education and training, will do much to decrease the accident and death rates associated with mining.

FILL IN THE BLANKS

STATISTICS PROVE THAT MINING IS A _____ OCCUPATION AND AS A RESULT
_____ HAVE BEEN PASSED TO ENFORCE SAFE AND HEALTHFUL PRACTICES.

Answer: hazardous, laws

The Law

Prior to 1977, miners' working conditions were governed by two separate laws: the Federal Coal Mine Health and Safety Act of 1969, and the Federal Metal and Nonmetallic Mine Safety Act of 1966. The problem with this situation was that the miners were not receiving training on health hazards. The 1977 Act also required the National Institute of Occupational Safety and Health (NIOSH) to conduct research and establish limits for contaminants in the workplace.

Mine Hazards

There are many potential safety and health hazards in underground and surface mines. Precautions are taken and safety programs enacted, but their effectiveness depends on individual safety consciousness and a good industrial hygiene program. Everything you will learn concerning health and safety in the mines will be useless unless you practice and utilize what you learn.

FILL IN THE BLANKS

HEALTH AND SAFETY EFFECTIVENESS IS DEPENDENT UPON _____
_____ AND A GOOD _____ PROGRAM.

Answer: safety consciousness, industrial hygiene

9D

Why then do unsafe acts happen? Safety rules may not be enforced, or perhaps they are not known to the miners. Often, rules are simply ignored. Some miners may be unwilling to accept new safety measures because they think they know best how to do their jobs. Also, some miners think they are immune to accidents. Perhaps a miner has gotten by with unsafe acts before and as a result thinks nothing will happen to him. It may also be "easier" not to follow the rules.

It is very important, especially in the mining industry, that everyone follows all safety rules and procedures. Personal factors (for example, recklessness, excitability, and ignorance of safe practices) are often the causes of accidents and injury. In any case, not following safety rules only leads to more accidents; it does not increase efficiency. Most accident prevention methods are just common sense and apply to everyone.

FILL IN THE BLANKS

RECKLESSNESS, EXCITABILITY, AND CARELESSNESS ARE EXAMPLES OF _____
_____ WHICH OFTEN CAUSE ACCIDENTS.

Answer: personal factors

Your industrial hygiene program should focus on your specific situation as a miner--underground or surface mining--and the industrial hygiene problems associated with the job. In addition to the human factor, general mine hazards include mine gases, dust, radiation, noise and vibration, poor illumination, and physical exertion and stress in a range of temperatures and humidities. Many of the hazards are associated with the underground mine atmosphere (for example, explosions, asphyxiations, lung diseases). Let's now take a look at each of these hazards as they occur in underground and surface mining operations.

FILL IN THE BLANKS

ALTHOUGH MANY OF THE HAZARDS IN THE MINING INDUSTRY ARE ASSOCIATED WITH UNDERGROUND MINE ATMOSPHERE, YOUR INDUSTRIAL HYGIENE PROGRAM SHOULD FOCUS ON YOUR _____.

 Answer: specific situation

Mine Atmosphere and Gases

First, let's discuss the mine atmosphere and the gases that make up the atmosphere since many potential hazards (explosions, asphyxiation, lung disease) result from mine dust and gases.

Air is the common mixture of gases found in operating mines. It supplies the oxygen needed by those who go underground. In addition, it removes undesirable gases and dust produced during mining. Also, in deep mines it may be used to remove heat and cool the miners.

As air passes through a mine, it picks up other gases as well as the dust formed during mining. At the same time, air loses oxygen to the surroundings and to the men in the mine (that is, oxygen is absorbed by coal, the other rocks and timbers, and is also consumed by men). In addition, during the winter months, most mines tend to dry out. The reverse process occurs in the summer, so that mines during this season of the year become damp.

CIRCLE THE CORRECT ANSWER

THE MOST COMMON GAS FOUND IN AN OPERATING MINE IS:

- A. AIR
- B. OXIDES OF NITROGEN
- C. CARBON DIOXIDE
- D. METHANE

 Answer: A

 12D

The amount of oxygen consumed by people working in a mine depends in part on the rate at which they work. As an individual's exercise rate increases and becomes more vigorous the more oxygen the individual will consume.

However, the composition of mine air also depends on the rate at which air flows through the mine. Under normal conditions, the flow rate is specified in such a manner that the contaminant gases do not render the air unsafe for human use.

FILL IN THE BLANKS

THE AMOUNT OF OXYGEN IN A MINE IS DETERMINED BY INDIVIDUAL _____
 AND THE MINE _____.

 Answer: consumption, airflow

 13D

The current standards for coal mines (30 CFR 75.301) prescribe that: all active workings shall be ventilated by a current of air containing not less than 19.5 volume per centum of oxygen, not more than 0.5 volume per centum of carbon dioxide, and no harmful quantities of other noxious or poisonous gases; and the volume and velocity of the current of air shall be sufficient to dilute, render harmless, and to carry away, flammable, explosive, noxious, and harmful gases, and dust, and smoke and explosive fumes. The minimum quantity of air reaching the last open crosscut in any

pair or set of developing entries and the last open crosscut in any pair or set of rooms shall be 9,000 cubic feet a minute The minimum quantity of air in any coal mine reaching each working face shall be 3,000 cubic feet a minute. Further 30 CFR 75.301-2 states that: Concentrations of noxious or poisonous gases, other than carbon dioxide, shall not exceed the current threshold limit values (TLV) as specified and applied by the American Conference of Governmental Industrial Hygienists.

Similarly, for metal and nonmetallic mines 30 CFR 57.5-1 states: . . . the exposure to airborne contaminants shall not exceed, on the basis of a time weighted average, the threshold limit values adopted by the American Conference of Governmental Industrial Hygienists, as set forth and explained in the 1973 edition of the Conference's publication. . . .

Surface mines present an interesting situation concerning air contamination. Although there is less likelihood of dangerous levels of gases becoming trapped in aboveground mines, it is possible. Poor air circulation in a pit with heavy haulage traffic and excavating machinery might create a hazard. A miner working in and around running equipment, especially in enclosed areas where engines are running, may be exposed to carbon monoxide gases.

Contaminant gases are often produced in mines under both normal and abnormal conditions. For example, fires, diesel engines, blasting operations, and in some cases, the coal and the adjacent strata also liberate harmful gas. Diesel engines, fires, and explosives may produce carbon monoxide as well as oxides of nitrogen. Other gases (methane, hydrogen sulfide, excess nitrogen, hydrogen) are also found in some mines.

TRUE OR FALSE

MINING CONDITIONS MAKE IT POSSIBLE FOR A WORKER TO BE EXPOSED TO VARIOUS CONTAMINANT GASES. _____

Answer: true.

Taking all this into consideration, oxygen is the gas that is most important to you because it is needed to support life. It is colorless, odorless, and tasteless, and slightly heavier than air.

Air usually contains 21 percent oxygen, although we can function satisfactorily with lesser or greater amounts. However, when oxygen content drops below 16 percent most people will have some breathing difficulty. At oxygen levels below about 10 percent many people become unconscious. In a methane-free atmosphere containing about 16 percent oxygen, a flame safety lamp is extinguished, and as you know you never enter an area when a flame safety lamp is extinguished.



FIGURE 2D. FLAME SAFETY LAMP

FILL IN THE BLANKS

THE GAS THAT IS MOST IMPORTANT IS _____, HOWEVER, WHEN THE LEVEL OF THIS GAS GOES BELOW _____ PERCENT, PERSONS WILL EXPERIENCE _____.

Answer: oxygen, 16, breathing difficulty

Oxygen concentrations above those found in the atmosphere, and air at abnormal pressures, may produce safety and health hazards that can affect the body adversely. For this reason, special care must be taken when working in tunnels under such conditions because of the presence of higher than normal oxygen pressure.

Nitrogen is also found in the atmosphere and in some rocks. This colorless, odorless, tasteless gas normally makes up 78 percent of the air we breathe. However, it is slightly lighter than air, and is the main dilutant of oxygen in the air.

Nitrogen becomes dangerous only when it takes up such a large part of the atmosphere that oxygen is driven out. This creates an oxygen deficiency that causes buzzing in the ears, rapid heartbeat, and a dizzy feeling.

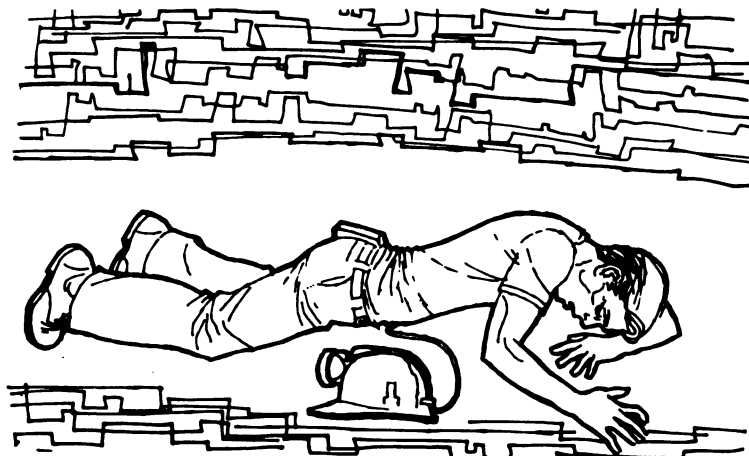


FIGURE 3D. AN OXYGEN-DEFICIENT ATMOSPHERE WITH AN EXCESSIVE AMOUNT OF NITROGEN WILL NOT SUSTAIN LIFE

FILL IN THE BLANKS

THE MAIN DILUTANT OF OXYGEN IN THE ATMOSPHERE IS _____ WHICH IN SUFFICIENT AMOUNTS CAN CAUSE _____.

Answer: nitrogen, oxygen deficiency

In addition to nitrogen and oxygen, other gases make up the remaining 1 percent of the normal atmosphere. Although these gases are found in small concentrations compared to oxygen and nitrogen, they can be dangerous when their TLV's are exceeded.

One of these gases is carbon dioxide. It is found in the soil, in coal, and in many rocks and is formed by living animals, fires, and explosions. Carbon dioxide is colorless with a slight acid taste when present in the air in high concentrations.

Carbon dioxide, however, has several peculiar properties of interest to the miner. First, it is heavier than air and so it tends to flow into low-lying areas. Next, because of its role in the respiration process, the body can tolerate only small quantities in the surrounding air. For example, we find that even one-half of 1 percent carbon dioxide affects our breathing. Miners exposed to this concentration breathe a little deeper and faster, that is, their lung ventilation increases. When 3 percent carbon dioxide is present in the air, lung ventilation doubles. A 10 percent carbon dioxide level can be tolerated for only a few minutes, because at this point the lungs cannot accept and exchange any more oxygen. (See Figure 4D below.)

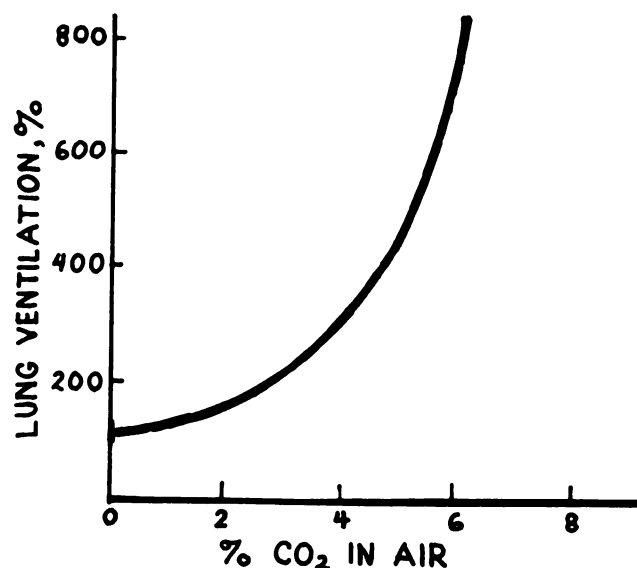


FIGURE 4D. THE SUPPLY OF OXYGEN THROUGH THE LUNGS INCREASES WITH AN INCREASE IN THE CARBON DIOXIDE (CO₂) CONCENTRATION

CIRCLE THE CORRECT ANSWER

HIGH CONCENTRATIONS OF CARBON DIOXIDE TEND TO

- A. PRODUCE ACID IN THE ATMOSPHERE
- B. INCREASE LUNG VENTILATION
- C. CAUSE EXPLOSIONS
- D. GATHER AT THE ROOF OF A MINE

Answer: B

22D

Another gas, carbon monoxide, is colorless, odorless, and tasteless, but it is slightly lighter than air. By law, carbon monoxide is never to exceed .005 percent (50 ppm) of a mine atmosphere. This gas is produced by fires and heated combustibles. A miner working around running equipment, especially in enclosed areas, may be exposed to carbon monoxide poisoning. Since carbon monoxide has no locally irritating effects, an individual may never realize the danger that is present.

FILL IN THE BLANKS

HEALTH HAZARDS CREATED BY _____ OFTEN GO UNNOTICED
BECAUSE THIS GAS HAS NO LOCALLY IRRITATING EFFECTS.

Answer: carbon monoxide

23D

Carbon monoxide poses a health problem because it combines more readily than oxygen with the hemoglobin of the blood. Once the hemoglobin combines with carbon monoxide, it cannot combine with oxygen, therefore the oxygen-carrying capacity of the blood is limited. For example, a concentration of 500 ppm of carbon monoxide in the air is enough to kill a person in a matter of just 3 hours. (See Figure 5D1.) This concentration would block about 50 percent of the hemoglobin in the blood. (See Figure 5D2.)

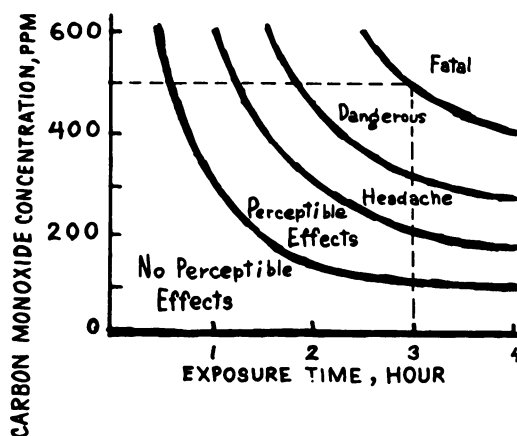


FIGURE 5D(1). EFFECTS OF CARBON MONOXIDE CONCENTRATIONS AND EXPOSURE TIME ON HUMANS

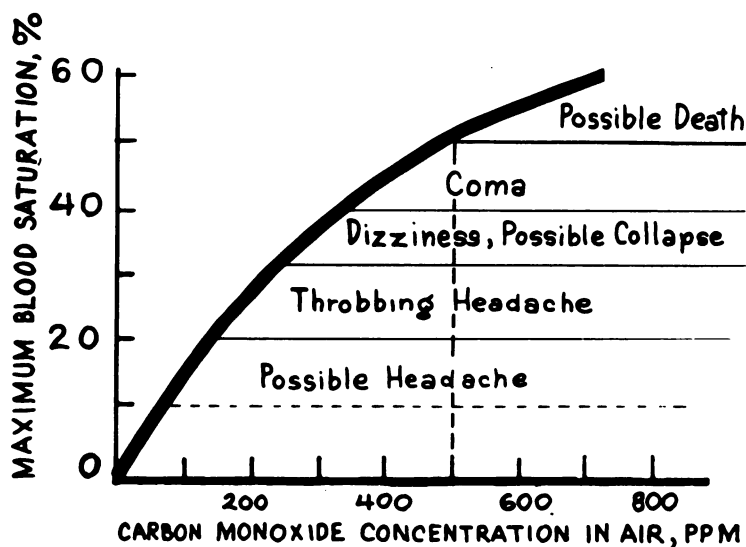


FIGURE 5D(2). LONG-TERM EFFECTS OF CARBON MONOXIDE IN COMBINATION WITH THE HEMOGLOBIN OF THE BLOOD

The rate that carbon monoxide combines with blood depends on exposure time, the concentration of the gas, and the activity of the individual who is exposed. (The more strenuous the activity the faster the blood saturation.)

Carbon monoxide in large amounts is also flammable. Such amounts of carbon monoxide may be formed following a fire or explosion. However, the greatest danger to a miner is from breathing carbon monoxide. Properly maintained equipment and good ventilation will reduce the risk associated with the gas because this gas can be a killer in poorly ventilated areas.

FILL IN THE BLANKS

THE BIGGEST CARBON MONOXIDE THREAT TO A MINER COMES FROM _____ THE GAS IN _____ AREAS.

Answer: breathing, poorly ventilated

Methane is another gas found in mines. It is the most common flammable gas found in coal and in rocks that contain combustible materials. Methane is an odorless, colorless, tasteless, highly flammable gas which when released tends to rise to the roof area of a mine because it is lighter than air. Methane also acts like nitrogen and reduces the oxygen concentration by dilution when mixed with air. This characteristic causes methane to act as an asphyxiant.

It is estimated that in the past 60 years over 10,000 deaths have occurred in the nation's coal mines as a result of the presence of this gas. Most of these deaths were due primarily to the fact that when methane concentrations reached 5 to 15 percent in the air, flammable explosive mixtures were produced. Once ignited, the flames tend to produce toxic products such as carbon monoxide, oxygen-deficient atmospheres, and in many cases go on to ignite dust, timber, coal, and other combustibles.

FILL IN THE BLANKS

TWO HAZARDS THAT CAN RESULT FROM EXCESSIVE AMOUNTS OF METHANE ARE _____ AND _____.

Answer: explosions, asphyxiation

Methane therefore is not permitted to accumulate in mines. The regulation found in 30 CFR 75.309 states: If, when tested, a split of air returning from any working section contains 1.0 volume per centum or more of methane, changes or adjustments shall be made at once in the ventilation in the mine so that such returning air shall contain less than 1.0 volume per centum of methane.

Another flammable gas is hydrogen. It is lighter than air and as a result tends to rise to the roof area of a mine. However, this gas is not normally found in mine air unless a fire or explosion has occurred, although small quantities may be found near battery charging stations. Hydrogen is colorless, odorless, tasteless, and forms flammable mixtures with air when the atmosphere contains at least 4 percent of hydrogen.

FILL IN THE BLANK

A FLAMMABLE GAS THAT IS NOT NORMALLY FOUND IN MINE AIR EXCEPT AROUND BATTERY CHARGING STATIONS IS _____.

Answer: hydrogen

Oxides of nitrogen can also create a hazard. They are formed at high temperatures by diesel and gasoline engines, electrical discharges, and blasting operations. Most of these gases are harmful because they form corrosive acids when mixed with the moisture in the lungs. The TLV's of these gases are listed as 25 ppm for nitric oxide and 5 ppm for nitrogen dioxide. These gases are readily detectable and usually cause no difficulty as long as proper precautions are available to dilute them with fresh air as they are formed.

FILL IN THE BLANKS

DIESEL AND GASOLINE ENGINES AS WELL AS BLASTING OPERATIONS IN THE MINES TEND TO FORM OXIDES OF _____ AT HIGH TEMPERATURES, HOWEVER, THEY WILL USUALLY CAUSE NO DIFFICULTY IF THEY ARE _____ WITH FRESH AIR.

Answer: nitrogen, diluted

Nitrogen dioxide is the main oxide of interest. This gas is almost colorless in low concentrations and becomes reddish-brown at higher concentrations. Nitrogen dioxide is heavier than air, has the odor of blasting fumes, and is quite irritating. It causes throat and lung irritation when inhaled in even small concentrations.

Sulfur dioxide is a colorless, suffocating, irritating gas with an easily recognized, bad, sulfurous smell. This gas is also much heavier than air. It is formed in fires that involve iron pyrites and occurs when blasting for certain sulfide ores. It has a rather low threshold limit value (5-parts-per-million of air) but, because it is an extreme irritant, it is very easy to detect. For this reason a person is not apt to remain for any length of time in an atmosphere that contains this gas. This gas irritates the upper respiratory system.

FILL IN THE BLANKS

A PERSON IS NOT LIKELY TO REMAIN IN AN ATMOSPHERE CONTAINING _____
_____ BECAUSE IT IS AN EXTREME IRRITANT AND EASY TO DETECT.

Answer: sulfur dioxide

At low concentrations hydrogen sulfide, however, is a colorless, toxic, flammable gas that has an odor of rotten eggs. It is also an irritant and is heavier than air. Unfortunately, prolonged exposure to hydrogen sulfide tends to dull the sense of smell. Therefore, a miner should not rely fully on the sense of smell for detection of this gas. Hydrogen sulfide has a threshold limit value of 10-parts-per-million of air and forms flammable mixtures (with air) over the concentration range of 4-to-44-volume percent. It is formed when blasting for sulfide ores and occurs in some natural gas, oil, and coal fields. Inhalation of high concentration of this gas causes paralysis of the respiratory system and almost sudden death.

FILL IN THE BLANKS

PROLONGED EXPOSURE TO _____ MIGHT DULL AN INDIVIDUAL'S
SENSE OF SMELL AND DETECTION LEADING TO DEATH.

Answer: hydrogen sulfide

Usually gases are not found by themselves but are found in mixtures which make their detection more difficult. The mixtures of these gases have been rather unique names. Firedamp is a mixture of methane and traces of other gases found in the air. Afterdamp is the gaseous products and smoke produced by a fire or explosion. Afterdamp consist of carbon monoxide, carbon dioxide, water vapor, nitrogen, oxygen, hydrogen, and hydrocarbons. Blackdamp occurs in oxygen-deficient atmosphere and is composed of carbon dioxide and nitrogen. Rock gas is another carbon dioxide and nitrogen mixture which creates an oxygen-deficient atmosphere. Normally, however, this particular gas mixture enters the mine from the adjacent rock strata at ordinary atmospheric pressures.

FILL IN THE BLANK

THE FACT THAT GASES ARE OFTEN FOUND AS _____ MAKES THEIR DETECTION EVEN MORE DIFFICULT.

Answer: mixtures

Smoke is another air contaminant. It consists of very small particles that often originate from the combustion or incomplete combustion of carbon-containing materials such as coal. Although smoke may irritate the nose and throat when inhaled, it is normally not considered to be an asphyxiating material. However, smoke may mix with gases such as carbon monoxide and other vapors produced by a fire making it dangerous for a person to inhale.

There might be a time when you find yourself in an area that is not well ventilated. Abandoned areas should be approached with care. These areas may be structurally unsafe, as well as oxygen deficient. In addition, large amounts of methane may have collected; carbon dioxide and hydrogen sulfide may have accumulated near the mine floor; and hydrogen sulfide may also have collected in stagnant ground water. Other dangerous gas mixtures may also have formed.

Whatever the situation, lack of air movement is one clue that harmful gases may have accumulated. To prevent being caught unaware by dangerous gases, continually check the mine atmosphere with a gas detector or flame safety lamp. Be prepared to use your self-rescuer if a dangerous situation develops.

If you must work in areas containing dangerous gas, you should use a gas mask or respirator. Gas masks provide protection from limited concentrations of harmful gases but cannot be used safely in an oxygen-deficient area. If there is not at least 19.5 percent oxygen in the atmosphere, you need a respirator that supplies pure air or oxygen.

FILL IN THE BLANKS

ABANDONED AREAS SHOULD BE APPROACHED WITH GREAT CARE BECAUSE HARMFUL _____
MAY HAVE COLLECTED IN THE AREA OR THE AREA MIGHT BE _____.

Answer: gases, oxygen deficient

The chance that any of these gases will accumulate to a dangerous level is reduced by mine ventilation. Your responsibility as a miner requires you to see that good ventilation is maintained. Because ventilation is the primary means of preventing accumulation of dangerous levels of mine gases, putting equipment where it might block the flow of fresh air may create a hazardous situation. Monitoring the environment using gas detectors or a flame safety lamp assures that proper ventilation is occurring. On the rare occasion you may need to use a personal protective device, such as a self-rescuer, it must be kept in mind that it does not provide a source of oxygen. The self-rescuer is for emergency escape only and the oxygen level must be greater than 16 percent for it to be effective.

In short, all underground workers must be aware of the hazards associated with mine gases, and they must take all the necessary precautions to prevent the creation of abnormal conditions. However, when such conditions exist, they should be able to recognize them and take the necessary steps to protect themselves and their co-workers.

FILL IN THE BLANKS

THE COLLECTION OF DANGEROUS GASES CAN BE REDUCED BY MINE _____
AND ALL WORKERS MUST BE CAREFUL NOT TO PUT EQUIPMENT WHERE IT BLOCKS THE FLOW
OF _____.

Answer: ventilation, fresh air

The following information might be helpful --
have discussed.

37D

Gas

12. THE GASES AND SMOKE PRODUCED BY FIRES AND EXPLOSIONS IN THE MINES CONSISTING OF CARBON MONOXIDE, CARBON DIOXIDE, NITROGEN, OXYGEN, HYDROGEN, HYDROCARBONS, AND WATER VAPOR IS _____.
13. MIXTURES OF CARBON DIOXIDE AND NITROGEN IN AN OXYGEN-DEFICIENT ATMOSPHERE IS CALLED
 - A. AFTERDAMP
 - B. BLACKDAMP
 - C. FIREDAMP
 - D. ROCK GAS
14. A HELPFUL CLUE THAT MAY INDICATE HARMFUL GASES HAVE ACCUMULATED IN AN UNVENTILATED OR ABANDONED AREA IS _____.
15. THE PRIMARY MEANS OF PREVENTING THE ACCUMULATION OF DANGEROUS MINE GASES IS _____.

- Answers:
1. indirect causes, basic causes
 2. cooperation, support
 3. underground areas
 4. false
 5. oxygen, remove
 6. b
 7. b
 8. carbon monoxide
 9. methane
 10. d
 11. hydrogen sulfide
 12. afterdamp
 13. b
 14. lack of air movement
 15. ventilation

If the correct answers to the review questions were not before moving ahead.

The remainder of the course will deal with radiation illumination, noise, dust, and ergonomic factors found

4. TRUE/FALSE - UNDER THE FEDERAL MINE SAFETY AND HEALTH ACT OF 1977, MINE OPERATORS CAN OBTAIN VARIANCES FOR HEALTH HAZARDS. _____
5. AIR NOT ONLY SUPPLIES _____ BUT IT IS ALSO USED TO _____ HARMFUL GASES.
6. A FLAME SAFETY LAMP WILL CONTINUE TO BURN IN AN ATMOSPHERE THAT
 - A. CONTAINS LESS THAN 16 PERCENT OXYGEN
 - B. HAS MORE THAN 16 PERCENT OXYGEN
 - C. CAUSES UNCONSCIOUSNESS DUE TO LACK OF OXYGEN
 - D. CONTAINS NO OXYGEN
7. EXCESS AMOUNTS OF NITROGEN IN A MINE ATMOSPHERE CAUSES
 - A. EXPLOSIONS
 - B. OXYGEN DEFICIENCY
 - C. FIRES
 - D. NONE OF THE ABOVE
8. A GAS THAT HAS NO LOCALLY IRRITATING EFFECTS, IS LIGHTER THAN AIR, FLAMMABLE, AND IN SUFFICIENT AMOUNTS DECREASES THE OXYGEN-CARRYING CAPACITY OF THE BLOOD IS _____.
9. THE MOST COMMON FLAMMABLE GAS FOUND IN COAL AND OTHER ROCKS CONTAINING COMBUSTIBLE MATERIAL IS _____.
10. OXIDES OF NITROGEN ARE FORMED BY
 - A. DIESEL ENGINES
 - B. BLASTING
 - C. GASOLINE ENGINES
 - D. ALL THE ABOVE
 - E. NONE OF THE ABOVE
11. AN INDIVIDUAL'S SENSE OF SMELL CAN BE DULLED BY PROLONGED EXPOSURE TO _____.

12. THE GASES AND SMOKE PRODUCED BY FIRES AND EXPLOSIONS IN THE MINES CONSISTING OF CARBON MONOXIDE, CARBON DIOXIDE, NITROGEN, OXYGEN, HYDROGEN, HYDROCARBONS, AND WATER VAPOR IS _____.
13. MIXTURES OF CARBON DIOXIDE AND NITROGEN IN AN OXYGEN-DEFICIENT ATMOSPHERE IS CALLED
- A. AFTERDAMP
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15. THE PRIMARY MEANS OF PREVENTING THE ACCUMULATION OF DANGEROUS MINE GASES IS _____.
-

- Answers:
- 1. indirect causes, basic causes
 - 2. cooperation, support
 - 3. underground areas
 - 4. false
 - 5. oxygen, remove
 - 6. b
 - 7. b
 - 8. carbon monoxide
 - 9. methane
 - 10. d
 - 11. hydrogen sulfide
 - 12. afterdamp
 - 13. b
 - 14. lack of air movement
 - 15. ventilation

If the correct answers to the review questions were not clear, review before moving ahead.

The remainder of the course will deal with radiation, heat stress, illumination, noise, dust, and ergonomic factors found in the mining industry.

Radiation

Radiation, especially in uranium mines, presents to the worker a hazard that cannot be seen. It is a hazard that also cannot be detected by feel, smell, sound, or taste. Many people know mining is a hazardous job. However, few people are aware of the deaths from lung cancer among miners affected by airborne radiation, which cause can always be traced to uranium and thorium minerals.

Aside from the few exceptions of small amounts of radioactive gases that seep through water and cracks in the earth, there are no high levels of radiation in the coal mines of this country. The major radiation source and potential hazard in coal mines and other mineral processing plants and mills comes from nuclear gages. These gages are designed to generate radiation for the purpose of monitoring a particular industrial process.

TRUE OR FALSE

RADIATION IS ONLY A HAZARD IN URANIUM MINES. _____

Answer: False

39D

Radioactive gases in a uranium mine, for example, even in small doses, can become a serious health hazard. This hazard is usually created by radon daughters. These radon daughters become attached to the airborne dust in the mine air, and as a result, airborne radiation is produced that can be inhaled by the workers.



FIGURE 6D. AIRBORNE RADIATION HAZARD

This form of energy once inhaled, is absorbed by the body cells and frequently causes changes to occur within the cells which eventually lead to cancer. As a result, these cells no longer function normally after becoming cancerous. In fact, the most prevalent cause of death due to radiation among miners is lung cancer which can result from such exposure.

FILL IN THE BLANKS

THE MAIN CAUSE OF MINING DEATHS DUE TO RADIATION IS _____
WHICH RESULTS FROM THE _____ OF CONTAMINATED RADIOACTIVE DUST.

Answer: lung cancer, inhalation

There is an additional hazard related to lung cancer among miners who are exposed to radiation. Those workers who are exposed to hazardous levels of radiation and who also smoke cigarettes on or off the job are about 10 times more likely to get lung cancer. Lung cancer related to radiation in mining occurs 6 or 7 years earlier among those who smoke. However, most lung cancer deaths among miners occur 10 or more years after they started working in the mine environment.

FILL IN THE BLANKS

A HUMAN BEHAVIOR THAT INCREASES THE LIKELIHOOD OF LUNG CANCER BY 10 TIMES AMONG MINERS EXPOSED TO RADIATION IS _____.

Answer: cigarette smoking

Measuring this radiation in a mine can be accomplished by using an air-sampling pump like the one pictured in Figure 9C. This instrument draws air through a filter on which the airborne radioactive particles collect. The trapped particles, containing the daughters, are then counted using accurate instruments. Thus the level of radiation is determined.

A special unit, called working level month (WLM), is used to calculate a worker's exposure to airborne radiation. Exposure to radiation involves two measurements, the level of radiation and the length of exposure in terms of time:

$$(\text{radiation level}) \times (\text{time}) = \text{exposure}.$$

This formula indicates that a person should not spend too much time in areas where high levels of radiation are known to exist. By the same token, if the levels of radiation are low, a person may be able to work safely without worrying about the time.

FILL IN THE BLANKS

ONCE A RADIATION SAMPLE IS OBTAINED A SPECIAL FORMULA CALLED A _____
_____ IS USED TO EXPRESS EXPOSURE LEVELS.

Answer: working level month (WLM)

Studies of uranium miners have shown that when the total exposure of a person exceeds 120 working level months, the person is more likely to get lung cancer. Assuming that individuals work 30 years, the maximum dose can be calculated:

$$(120\text{WLM}) \div (30 \text{ years}) = 4\text{WLM per year}$$

The present health standards state that individual exposures should be kept below the maximum allowable dose - that is below 4 WLM in any calendar year.

CIRCLE THE CORRECT ANSWER

WHICH OF THE FOLLOWING MEASUREMENTS WOULD INDICATE THE MOST HAZARDOUS RADIATION CONDITION?

- A. 3 WLM
- B. 4 WLM
- C. 2.7 WLM
- D. 5.5 WLM

Answer: D

Uranium mines, and other mines where high levels of radiation are expected to be a problem, should be developed in a special way to reduce employee exposure to radiation. These mines should have a ventilation system capable of delivering uncontaminated air to the work areas. In fact, the only practical and legally acceptable method of controlling radiation is by ventilation. Ventilation should provide not only enough air but air that is of a high standard of quality for the workers. Circulation is of primary importance and neglecting to close doors, hang curtains properly, or prevent obstructions by equipment, only increases your chances of exposure to radiation and mine gases.

FILL IN THE BLANK

THE MOST ACCEPTED METHOD USED FOR THE CONTROL OF RADIATION HAZARDS IS

_____.

Answer: ventilation

In order to prevent employee exposure to radiation in an emergency situation, air purifying respirators should be used. Such an emergency might occur if employees find themselves working in poorly ventilated areas for short periods of time. An emergency situation might also exist if workers are required to enter abandoned mine workings. Remember though, respirators designed only to filter out particulate radiation do not stop radioactive gas from entering the lungs.

Radiation is indeed a health hazard found in certain mining operations. Cancer of the lungs may be caused by occupational exposure to airborne radiation in mines and mills. However, the risk of this fatal disease may be tenfold for those who smoke cigarettes. Effective ventilation can maintain the airborne radiation at the work site below the maximum allowable levels. In addition, education of employees on the hazards of ionizing radiation and cigarette smoking, along with regular medical checkups will reduce the incidence of lung cancer among uranium mine workers.

FILL IN THE BLANKS

LUNG CANCER RELATED TO RADIATION AND MINING CAN BEST BE REDUCED THROUGH
_____, _____, AND _____.

Answer: ventilation, education, medical checkups

Heat Stress

The search for new sources of minerals requires the expansion of underground mining in deeper, and therefore, hotter levels of the earth's crust. In mining, as in other industries, the exposure of workers to very hot conditions is unhealthy, unproductive, and causes workers to ignore unsafe working situations. An increased amount of heat will interfere with an individual's metabolism and cause health problems such as heatstroke, fainting, exhaustion, cramps, and dehydration or water deficiency.

TRUE OR FALSE

HEAT CAN IN FACT MAKE A PERSON UNAWARE OF UNSAFE WORKING CONDITIONS RESULTING IN ACCIDENTS. _____

Answer: True

47D

Generally speaking, temperatures on the job, humidity, and air movement (ventilation) can be controlled to reduce heat at the work site. However, at a point these controls fail to prevent an individual's body temperature from rising. Work practices may then be the only heat-stress control measure. Some desirable work practices to consider when working in a hot environment are:

- frequent breaks and reasonably short work periods
- pacing your work tasks
- rotating personnel on hot jobs
- providing readily accessible cooler rest areas, and cool and slightly salted drinking water.
- long-term adjustment of an individual to heat (acclimatization)

FILL IN THE BLANKS

IF PROPER VENTILATION IS NOT ADEQUATE TO REDUCE HEAT STRESS, PROPER _____
_____ MAY THEN BE THE ONLY HEAT STRESS CONTROL MEASURE.

Answer: work practices

Such things as the sun, machines, power equipment, lighting system, etc., contribute to the heat load in either a surface or underground mine. Also a miner's body releases a certain amount of energy in the form of heat to the mine air especially in a crowded work area. Ventilation, shielding, canopies outside, using more efficient equipment, and possibly automation could control such factors. However, education concerning the signs and symptoms of heat stress, proper first aid procedures, and techniques to reduce heat stress are perhaps a miner's best defense against this particular stress factor.



FIGURE 7D. EDUCATION!

FILL IN THE BLANK

SHIELDING, AUTOMATION, AND MORE EFFICIENT MACHINES ARE ALL CONTROL MEASURES USED AGAINST HEAT, HOWEVER, AN INDIVIDUAL'S BEST PROTECTION IS THE RESULT OF _____.

Answer: education

Workers performing hazardous jobs while at the same time being exposed to temperatures in excess of 80 degrees are much more likely to have high accident rates. Excessive physical activity in hot work areas causes increased stress on the human body (higher sweat and heartbeat rates). Long-term exposure of non-acclimatized persons to heat stress is both unhealthy and unproductive. Proper selection of employees, adequate time for acclimatization of the worker, and education of people that are assigned to work in hot work sites, along with effective engineering controls of the existing heat problem, will allow for a healthier and more productive work environment.

CIRCLE THE CORRECT ANSWER

A BETTER WORK ENVIRONMENT UNDER HEAT STRESS CONDITIONS IS PROVIDED BY

- A. ACCLIMATIZATION AND EDUCATION
- B. ENGINEERING CONTROLS
- C. PROPER CHOICE OF EMPLOYEE
- D. ALL THE ABOVE
- E. NONE OF THE ABOVE

 Answer: D

50D

Dust and Noise

Two major health hazards in the mining industry are dust and noise. Both of these become more hazardous as the size and number of machines used in mining increase. First let's turn our attention to respirable dust. Respirable, if you remember, means capable of being taken in by breathing. So, respirable dust is that dust that can be breathed in.

When you are working in a mine, many types of dust, including respirable dust, will be around you because all mining produces dust like that illustrated in Figure 8D.

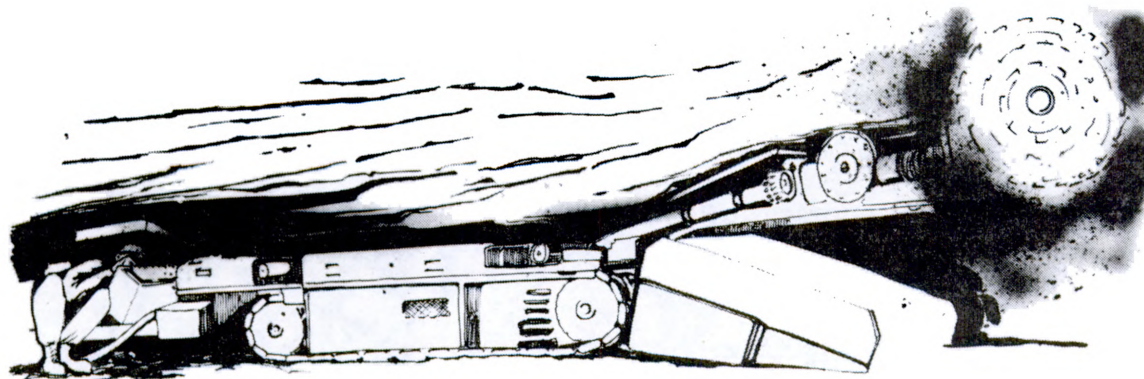


FIGURE 8D. MINING-GENERATED DUST

Non-coal miners extracting materials such as iron, lead, limestone, talc, potash, uranium, etc., may develop silicosis. Also, miners extracting asbestos can develop asbestosis and possibly cancer. On the other hand, the major dust related disease developed by coal miners is pneumoconiosis (more specifically coal workers' pneumoconiosis, CWP, or black lung). Usually these diseases result from long-term exposure to certain dust.

FILL IN THE BLANKS

THE MAJOR HEALTH HAZARD IN THE MINING INDUSTRY AFFECTING THE RESPIRATORY SYSTEM IS _____.

Answer: respirable dust

When dealing with coal dust, there are two major hazards associated with its presence. The fact that it is explosive creates a safety hazard. The other is a health hazard created by respirable coal dust. In fact, as a result of long periods of exposure, a miner's health may be affected so he or she may no longer be able to work in the mines or anywhere for that matter. The diseases that result might even cause death.

FILL IN THE BLANKS

DUST CAN BE CONSIDERED EXTREMELY HAZARDOUS BECAUSE IT CAN CAUSE BOTH
 _____ AND _____ PROBLEMS.

 Answer: health, safety

Because coal dust at a mine is a serious health and safety hazard, there are regulations regarding the amount of respirable dust in mine air. The law states that each operator of an underground coal mine shall continually maintain the average concentration of respirable dust in the workplace in the mine during each shift to which each miner in the active workings of such mine is exposed at or below 2 milligrams of respirable dust per cubic meter of air. In a surface coal mine, exposure levels of respirable dust at each work site and installation during each shift should be at or below 2 milligrams per cubic meter of air.

In regard to the explosive and fire hazard, employees must be trained to recognize and eliminate fire hazards, to evaluate and control fire, and to protect themselves and others from the hazards associated with fire. Such training should continue throughout the miner's employment and provide periodic reviews of the characteristics of fires, escapeways, emergency evacuation plans, and the use of extinguishers and personal protective equipment.

FILL IN THE BLANKS

THE POSSIBLE SERIOUS RESULTS OF A FIRE OR EXPLOSIONS CAN BE REDUCED THROUGH
 PROPER EMPLOYEE _____ THAT IS ASSOCIATED WITH PERIODIC _____
 OF THE CORRECT MATERIAL AND PROCEDURES.

 Answer: training, reviews

Generally speaking, the most effective dust control is done at the source of dust production. Water can be sprayed directly on the area where dust is created in order to reduce the amount of dust released into the air. Ventilation also reduces industrial hygiene hazards created by dust in the mining environment.

Even though there are controls to lower dust concentration levels in the mine, in some cases the amount of respirable dust in the air will still exceed what the law requires even when controls have been used. In cases like that, you will need to wear respiratory equipment while you work.

CIRCLE THE CORRECT ANSWER

CONTROLS USED IN THE PREVENTION OR REDUCTION OF RESPIRABLE DUST INCLUDE

- A. AVOIDANCE
- B. VENTILATION AND WATER
- C. RESPIRATORY EQUIPMENT
- D. ALL THE ABOVE
- E. B AND C

Answer: E

Thus far we have stated that ventilation is a method used to reduce dangerous exposure to mine gases, radiation, and dust. However, ventilation does not just mean providing the mining area with clean air. Equipment, especially operators' cabs of surface mining equipment, should also be well ventilated. This equipment should be ventilated so that dust or gas is not permitted to enter the cab area making the air dirty and hazardous.

Equipment which produces large amounts of heat should also be ventilated to prevent the buildup of heat or gas which could cause a fire or explosion. Most equipment manufacturers do take the necessary steps to provide for proper ventilation in the design and production of their equipment. Problems usually arise when someone tampers with the equipment or uses it improperly.

FILL IN THE BLANKS

VENTILATION OF EQUIPMENT IS DESIGNED TO PROVIDE FOR _____
AND REDUCES THE BUILDUP OF _____ OR _____.

Answer: clean air, heat, gases

Miners by the nature of their job are also frequently required to work around high noise levels. Noise therefore becomes an industrial health hazard of the mining industry. Miners in fact are constantly exposed to machinery noise from drills, shuttle cars, roof bolters, continuous miners, man trips, loaders, cutters, tractors, shovels, draglines, etc. Unfortunately, miners exposed to a lot of noise over long period of time seem to get used to hearing it. However, they are actually hearing less of the noise (going deaf). This fact makes noise a somewhat ignored health hazard. After an hour or so a miner becomes accustomed to the noise of his or her drill, continuous miner, or roof bolter, and does not realize that hearing is slowly being damaged.

FILL IN THE BLANK

BECAUSE YOU FEEL YOU ARE BECOMING ACCUSTOMED TO NOISE ON THE JOB, NOISE IS
CONSIDERED TO BE AN _____ HAZARD.

Answer: ignored

The intensity of sound is the pressure that is made when sound is produced and it is expressed in units called decibels. Miners, in fact, should not be exposed to more than an average of 90 decibels of noise over an 8-hour shift. Certain types of sound, however, do more damage than others. High frequency sounds are the most damaging and a very harmful combination is a high frequency sound with lots of intensity. (See Figure 9D)

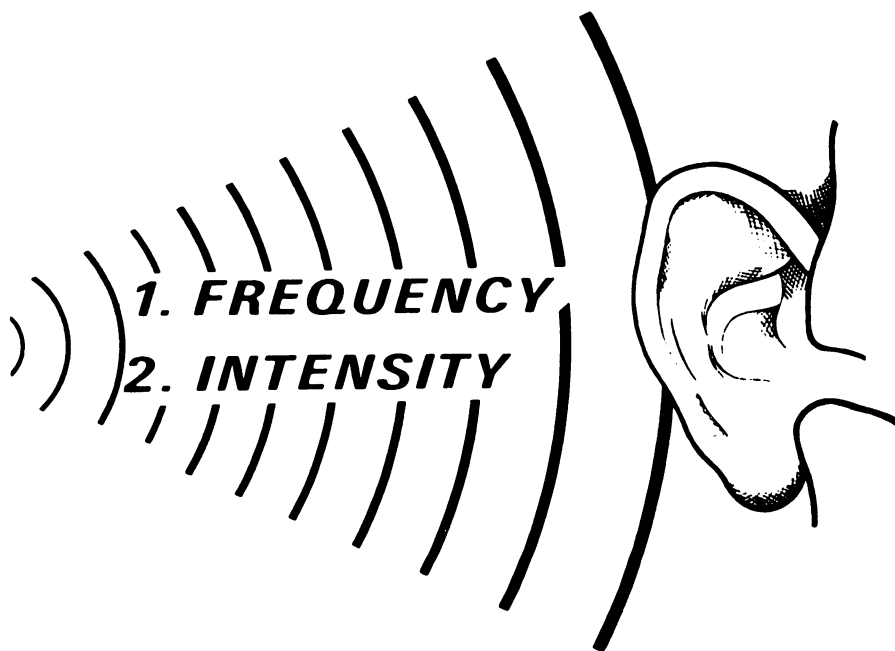


FIGURE 9D. FACTORS THAT AFFECT HEARING

To you this means the highest intensity sounds are the noisiest.

FILL IN THE BLANKS

THE TWO MAIN FACTORS OF NOISE THAT HAVE A DIFFERENT EFFECT ON AN INDIVIDUAL'S LEVEL OF HEARING ARE _____ AND _____.

 Answer: frequency, intensity

 58D

Sounds differ in intensity and frequency. There can also be various sources for sound. As a result, sound affects an individual's hearing differently.

Not all noise causes permanent damage. Your ability to hear depends on a number of things: the level and type of noise, the length of time you are exposed to the noise, the physical condition of your ears, and your age. Brief exposure to loud noise produces only a temporary loss. Hearing in this case can be regained after a short period of time. On the other hand a loud

continuous noise, such as that of a continuous miner, causes a gradual loss of hearing. This type of hearing loss over a period of time destroys the nerves of the ear, as a result the hearing loss can never be corrected.

Impact and impulsive noise, such as an explosion, can rupture the eardrum or parts of the inner ear. Hearing loss due to this type of noise can sometimes be corrected by surgery or with hearing aids if the ear does not fully repair itself.

TRUE OR FALSE

THE EFFECTS OF SOUND CAN EASILY BE PREDICTED FOR ALL INDIVIDUALS. _____

Answer: False

As we have discussed, noise can cause hearing loss. But this is not the only damage it can do. Prolonged exposure to noise can also affect the human circulatory system, causing constriction of the arteries, an increased rate of heartbeat, and an increased flow of adrenalin into the bloodstream. It has also been discovered that noise affects the nervous, endocrine, and reproductive systems, and it may even damage unborn children.

On the job, the most noticeable effect of noise will be that it interferes with your ability to hear and to be heard. A noise that is not intense enough to cause hearing damage may still disrupt on-the-job communication and keep you from hearing other sounds that you wish to hear such as commands or danger signals. This inability to hear commands or danger signals may also increase your chances of having an accident.

Noise on the job may also be annoying as well as make you tired. This also increases the probability that you will be careless and have an accident.

FILL IN THE BLANK

NOISE NOT ONLY RESULTS IN HEARING LOSS BUT ALSO INTERFERES NOTICEABLY WITH _____ ON THE JOB.

Answer: communication

Perhaps you are asking what can be done about noise? Regulations require that noise measurements be taken at prescribed intervals. These measurements are taken by trained personnel and the results should be of interest to you.

Engineering controls can be used to reduce sound through changes in the work environment. This is done by using sound absorbing material and re-designing and maintaining the workplace and the machines workers use. As a result sound intensity can be reduced.

Management can also help control noise through administrative controls. For example, a miner who is working in a relatively noisy area might on occasion work a different job. The decision to move the miner is made by someone in the administration. Ear protection can also be used to control noise. Personal protective equipment can thus be used to help control noise.

FILL IN THE BLANKS

WAYS OF CONTROLLING NOISE CAN BE PLACED INTO THREE DIFFERENT CATEGORIES WHICH ARE _____, _____, AND _____.

Answer: engineering, administrative, ear protection

Although there are many ways that noise can be controlled in the mine, probably the best way to do it is to get at the source of the noise. In and around the mine, most noise is caused by machinery. There is little you can do to make an explosion quieter, but since you generally know when it will be set off, you can take precautions against it.

However, what can be done about the noise made by machinery? Equipment noise can be reduced by lubricating noisy parts, replacing worn parts, muffling a noisy exhaust, or by making sure machine parts are mounted and balanced properly. You can also control noise by enclosing, baffling, or screening the noise source from yourself and others.

FILL IN THE BLANK

THE BEST PLACE TO ATTACK A NOISE PROBLEM IS AT THE _____ OF THE NOISE ITSELF.

Answer: source

In the mine, people may tell you all kinds of stories about the so-called hazards of protective hearing devices. No doubt someone will tell you that hearing protectors keep you from hearing such important sounds, commands or warnings, horns, or backup signals on trucks. Sometimes though you will lose your hearing temporarily if you are exposed to a loud noise. So even after a noisy piece of equipment is turned off, an operator who was not wearing an ear protective device may not be able to hear these sounds for awhile. The length of this could be minutes--or even hours. However, the machine operator who was wearing hearing protectors, would be able to hear these sounds the moment he or she removed their ear protection. Therefore, do not be put off by those who say muffs are hazardous. If you have them or can get them, wear them when you are working around noisy machinery.

TRUE OR FALSE

WEARING EAR PROTECTION CAN HELP PREVENT TEMPORARY HEARING LOSS AND IN FACT AID COMMUNICATION IN CERTAIN SITUATIONS. _____

Answer: True

Indeed two of the major health hazards in the mining industry are dust and noise. We said that of all types of dust found in mines, respirable dust is the most hazardous to your health because it can be breathed in. We mentioned several diseases that are caused by long exposure to respirable dust. One of these diseases caused by coal dust is black lung. We also said that respirable coal dust can also cause other health problems.

The basic health hazard of noise is that it can affect your hearing. It can also affect your ability to do a good job by interfering with on-the-job communication. Sometimes noise can even make it more likely that you will have an accident in the mine.

FILL IN THE BLANKS

DUST IS HARMFUL TO YOU BECAUSE IT CAN BE _____, WHILE THE BASIC HAZARD OF NOISE IS THAT IT AFFECTS YOUR _____.

Answer: breathed in, hearing

Both dust and noise can be harmful to your health. So remember, if you are in a situation where wearing a respirator or an ear protective device is called for--WEAR IT. Others may try to tell you that these devices are just a nuisance. However, you know better--respirators and ear protective devices safeguard your health. Remember, personal protective equipment is used in many accident prevention programs to protect workers from hazards that cannot be controlled by other means. Hazards are not eliminated through the use of personal protective equipment, but these devices serve to shield the worker should an unplanned release of energy or hazardous material occur.

Skin Disease

When considering the agents that cause dermatitis, 80 percent of the problem comes from chemicals. The best defense in any industrial environment is to change the process or materials, thus eliminating the irritating substances. If this is not possible, much can be done to enclose or remove dermatitis-causing substances before they reach the employee's skin.

Education and enforcement can also provide work methods that will reduce contact with irritants. Also, personal protective equipment, well made and well selected, provides a final barrier in those cases where other methods are not totally effective. Finally, personal cleanliness provides a major defense even after contact is made with a dermatitis-causing substance. The fight against industrial dermatitis includes all five of these preventive and protective efforts.

COMPLETE THE FOLLOWING SENTENCE

THE SUGGESTED METHODS FOR FIGHTING AND PREVENTING DERMATITIS INCLUDE:

_____,
 _____,
 _____,
 _____, AND
 _____.

Answer: changing the process or materials,
 enclosing or removing the dermatitis-causing substance,
 education and enforcement,
 personal protective equipment,
 personal cleanliness.

Illumination and Ergonomics

Poor visibility is a mining hazard which especially exists in underground mine areas. Although surface miners must deal with the darkness of night and bad weather, the dangers of personal injury and equipment damage are increased underground where visibility is totally dependent upon mine illumination (artificial lighting). Poor visibility underground can be reduced by adequate illumination.

Due to the ever-changing underground mining environment, it is necessary that underground lighting instruments be portable. Also, lights taken into or out of the last open crosscut, in return airways, and within 150 feet of a retreat area must be explosion proof.

FILL IN THE BLANKS

UNDERGROUND MINE ILLUMINATION MUST BE _____, _____, AND PROVIDE _____ LIGHT.

Answer: portable, safe, adequate

Underground lighting produces another problem, glare. Glare can be painful and may even cause permanent blindness. Temporary blindness, a more common occurrence resulting from glare, is caused by looking directly into the beam of light coming from a piece of machinery or cap lamp shining directly into your eyes. The real danger of glare is that the effects of it is cumulative, and leads to long-term, harmful effects on a miner. Glare, in fact, can gradually cause permanent damage to your vision over long periods of time.

Glare can be decreased by reducing contrast or using dimmer lights. Increasing illumination by rock dusting the roof and ribs of a mine also reduces glare. Refer to Figure 10D which illustrates the rock dusting procedures.

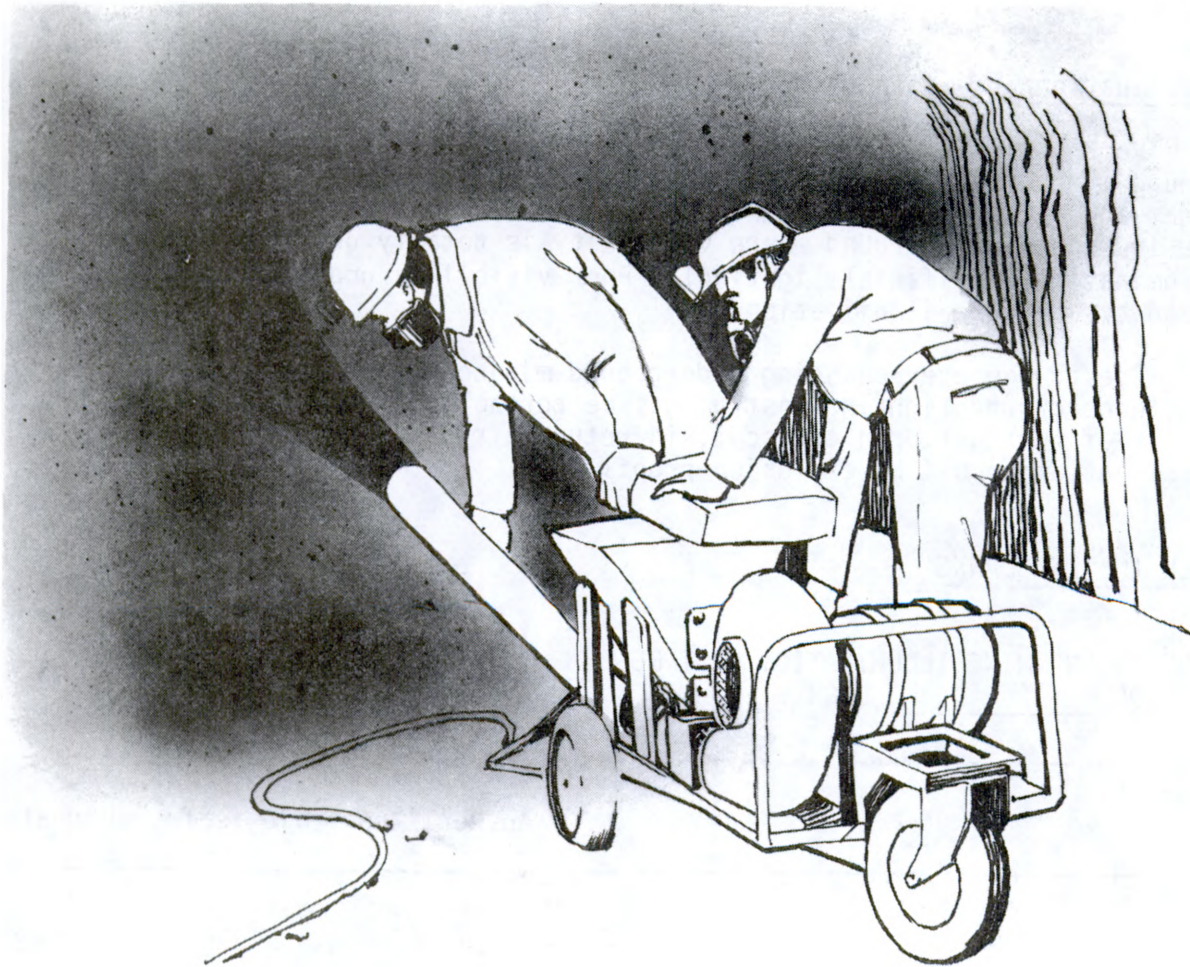


FIGURE 10D. ROCK DUSTING

Equipment painted in bright colors will also improve illumination as well as the visibility of the machine. This is the reason you will see most mine machines painted yellow or orange.

FILL IN THE BLANK

USING DIMMER LIGHTS AND ROCK DUSTING WILL AID IN REDUCING THE HAZARD OF _____ IN A MINE.

Answer: glare

Not enough illumination is also a problem that is just as common as the problems produced by too much illumination. A dim cap lamp or burnt out headlight lengthens the amount of time you have to react to potential dangers and hazards. Often when the lighting is poor, you do not have enough time to react to danger. You may not even be able to see that there is a problem.

Improving mine illumination is, therefore, important and can be accomplished by making sure the working area and haulageways are well lit. Illumination of stationary hazards, such as power sources and timbers in haulageways, can be accomplished by using reflectors. All machinery lamps should also be working and your cap lamp should be clean and throwing a strong beam of light. However, try not to blind anyone with your cap lamp or machinery lights.

TRUE OR FALSE

POOR ILLUMINATION IS DANGEROUS DUE TO THE FACT IT LENGTHENS THE TIME YOU HAVE TO REACT TO HAZARDOUS CONDITIONS. _____

Answer: True

In addition to mine gases, radiation, dust, noise, and poor visibility, ergonomic factors cause additional mining hazards. Working in unnatural positions, doing repetitive jobs, or lifting objects make a miner more prone to accidents. Studies have indicated that accidents occur more frequently when workers are tired and less alert as a result of exertion and stress. Two ways to prevent or reduce exertion or stress are:

- lift with the legs bent and the back straight;
- after working in one position for some time, attempt a different position and stretch or exercise in the opposite direction for a few moments.

Ergonomics factors do play a role in mining. For example, painting equipment bright colors makes it easier to see and recognize, reducing not only eyestrain and glare but also brain strain. Therefore, since a safe working environment is so important in underground mines, every possible action that cuts down ergonomic stresses must be taken. This is especially true in view of the fact that most injuries are due to human mistakes.

TRUE OR FALSE

ERGONOMICS FACTORS THAT ARE NOT CONTROLLED CAN PLAY A ROLE IN THE INCREASED OCCURRENCES OF ACCIDENTS IN A MINE. _____

Answer: True

72D

Inattentiveness is the most common human error. Inattentiveness may result from ergonomic stresses like fatigue, boredom, monotony, and discomfort from awkward equipment. For example, if equipment controls are not clearly marked, the operator might give more attention than necessary to the controls and may be distracted from the movement of the machine or miners working nearby. Also, if the operator's position is uncomfortable, the chances of injury or strain of the musculo-skeletal system increase. Indeed large-scale accidents involving other miners may result if the operator is tense instead of relaxed and alert, ready to react to emergencies.

FILL IN THE BLANKS

_____, THE MOST COMMON "HUMAN ERROR," MAY RESULT FROM FATIGUE, BOREDOM, MONOTONY, AND DISCOMFORT FROM AWKWARD EQUIPMENT. TO BE BEST PREPARED FOR EMERGENCY SITUATIONS, THE MACHINE OPERATOR MUST BE _____ AND _____.

Answer: inattentiveness, relaxed, alert

73D

The results of boredom are much like those of inattention. A bored worker thinks about what he would rather be doing instead of his present task. This also cuts down on the time necessary to react in case of emergency. Boredom may even cause the emergency. Miners must be alert at all times to keep from injuring themselves and others.

FILL IN THE BLANKS

_____ ALSO REDUCES THE TIME A MINER HAS TO REACT TO AN _____.

Answer: Boredom, emergency

Other Safeguards

At times, the not too friendly environment of the mine has made the miner aware of his need to be sure that his own body is properly protected. Loose fitting clothes should not be worn. Safety helmets and steel-toed shoes are mandatory. Goggles should be worn when working where objects may fly into the air. Sharp or rough materials should be handled with gloves to prevent cuts and infections. At times as a result of using this equipment you may consider yourself to be a strange looking creature. However, it is better to be a safe creature than an injured, diseased, or dead one.

TRUE OR FALSE

YOUR PERSONAL ATTENTION TO SAFETY AND THE PROPER USE OF PERSONAL PROTECTIVE EQUIPMENT DECREASES THE POSSIBILITY OF INJURY, DISEASE, OR EVEN DEATH. _____

Answer: True

75D

Since machinery failures can cause serious accidents, operators should be trained in proper operating procedures for both normal and emergency situations. Another safeguard is having machines maintained in the best condition. This will mean fewer breakdowns, thus reducing the probability of an accident. Quality maintenance will also be worthwhile because fewer repairs will be needed.

FILL IN THE BLANKS

TO REDUCE INJURIES FROM MACHINERY BREAKDOWNS, OPERATORS SHOULD BE TRAINED IN PROPER _____ FOR BOTH _____ AND _____ SITUATIONS.

Answer: operating procedures, normal, emergency

76D

Perhaps one of the least thought about yet most used safeguards, practiced especially in underground mines, is monitoring others and letting yourself be monitored. It takes no special equipment. Merely telling other miners where you are going and how long you will be gone is a good safety habit. If you should get into trouble and not be able to signal for help, someone will be checking for you when you do not return on time. Also, equipment operators will know where to expect you if they must work or travel near you.

COMPLETE THE FOLLOWING SENTENCE

ONE OF THE LEAST THOUGHT ABOUT SAFETY PRACTICES IN UNDERGROUND MINES IS

Answer: knowing the location of others as well as
letting others know your location

77D

Most accidents and health hazards can be prevented. However, an effective accident prevention and industrial hygiene program requires the complete support and cooperation of all employees--from top management down to the individual worker. Top management must develop a suitable safety and health policy (preferably in writing), furnish a safe and healthful workplace, set production goals with safety and health in mind, obtain suitable equipment and supplies, assign specific responsibilities at each level of authority, and hold individuals accountable for their actions. Each manager and first line supervisor must assume responsibility for their group, establish safe procedures, and conduct periodic inspections, safety meetings, training sessions, and investigations. In addition, each must keep accurate records of training, incidents, accidents, inspections, and of corrective actions taken to eliminate unsafe acts and conditions. Finally, each employee must develop a safety and health awareness and become familiar with the surroundings, the established rules, the hazards associated with each procedure (routine and emergency), and the proper use of handling of the equipment and supplies with which they work (including personal protective equipment). In addition, the worker must attend all required training sessions and safety meetings, and must protect themselves and their fellow workers in the event of an emergency situation.

TRUE OR FALSE

DUE TO THE LACK OF ACCIDENT PREVENTION TECHNIQUES, MOST ACCIDENTS ARE DIFFICULT TO PREVENT. _____

Answer: False

One of the major objectives of industrial hygiene is to make the working environment, in your case the mine, as healthy and safe a working place as possible. Proper industrial hygiene reduces the possibility of unsafe conditions and the chances of your committing unsafe acts. Before taking the self-evaluation test for this section, read the list of industrial hygiene practices below.

- Monitor the area for exposure to radiation
- Work in well ventilated areas
- Wear personal protective equipment
- Work in properly illuminated areas
- Protect against noise
- Lift properly
- Prevent excessive stress and exertion
- Be awake and well rested to start the job
- Be knowledgeable about safety equipment and warning devices
- Use only tools, supplies, and equipment that are in good working condition and safe
- Take your job seriously
- Keep a "clean" work area
- Learn to do the job properly and safely

Maybe you can add to the list of good industrial hygiene practices. Perhaps you've been neglecting a few of them. If so, the next time could be the last!

You are now ready to take the self-evaluation review for the final section of the course. Answer all the questions before checking your answers.

LET'S PAUSE AND REVIEW WHAT HAS BEEN COVERED IN THE FINAL PART OF SECTION D.

1. IT IS IMPORTANT FOR YOU TO HAVE A BASIC UNDERSTANDING OF INDUSTRIAL HYGIENE BECAUSE AS A MINE WORKER YOU WILL BE EXPOSED TO:
 - A. NOISE AND VIBRATION
 - B. DUST AND GASES
 - C. REPETITIVE MOTION
 - D. CHEMICALS, EXPLOSIVES
 - E. ALL THE ABOVE
2. RADIATION EXPOSURE IS KNOWN TO CAUSE A DREADED DISEASE CALLED _____ AND IF A MINER EXPOSED TO RADIATION SMOKES CIGARETTES, THE LIKELIHOOD OF LUNG CANCER INCREASES _____ TIMES.
3. THE BEST METHOD AVAILABLE TO CONTROL RADIATION IN A MINE IS BY:
 - A. ISOLATION
 - B. VENTILATION
 - C. WATER SPRAYS
 - D. PERSONAL PROTECTIVE EQUIPMENT
4. TRUE/FALSE - WORKING IN A HOT ENVIRONMENT CAN LEAD TO AN INCREASED ACCIDENT RATE. _____
5. DISEASES TO THE LUNGS CAN BE CAUSED BY:
 - A. POOR VISIBILITY
 - B. POOR VENTILATION
 - C. POOR ILLUMINATION
 - D. ALL THE ABOVE

6. PNEUMOCONIOSIS IS CAUSED BY:
- A. MINE GASES
 - B. MINE DUST
 - C. GLARE
 - D. ALL THE ABOVE
7. AN EXPLOSION CAN CAUSE WHICH OF THE FOLLOWING MINE HAZARDS?
- A. DUST
 - B. MINE GASES
 - C. NOISE
 - D. ALL THE ABOVE
8. NOISE FROM AN EXPLOSION IS AN EXAMPLE OF:
- A. PERMANENT HEARING LOSS
 - B. A CONTINUOUS NOISE
 - C. A CONTINUOUS HEARING LOSS
 - D. AN IMPACT NOISE
9. HIGH NOISE LEVELS:
- A. CAN TEMPORARILY DAMAGE HEARING
 - B. CAN CAUSE PERMANENT DEAFNESS
 - C. INTERFERE WITH COMMUNICATION
 - D. ARE OFTEN ACCOMPANIED BY VIBRATION
 - E. ALL THE ABOVE
10. NOISE NOT ONLY AFFECTS HEARING BUT IT ALSO INTERFERES WITH _____
AND THE BEST WAY TO ATTACK A NOISE PROBLEM IS TO ATTACK IT AT THE _____.

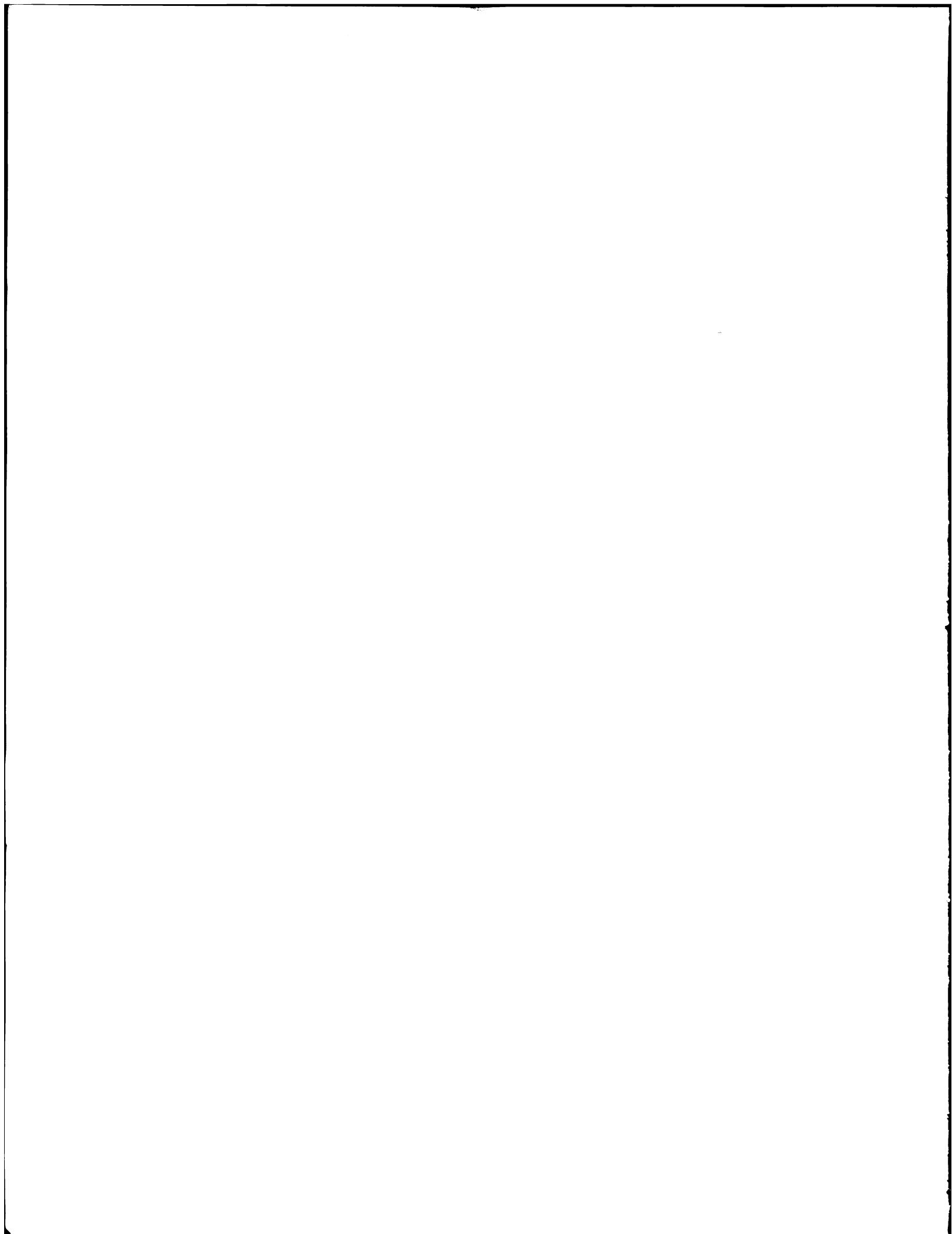
11. EIGHTY PERCENT OF ALL DERMATITIS PROBLEMS ARE THE RESULT OF _____ EXPOSURE.
12. GLARE IS PRODUCED BY:
- A. ROCK DUSTING
 - B. EXCESSIVE ILLUMINATION
 - C. DECREASED ILLUMINATION
 - D. BRIGHTLY PAINTED OBJECTS
13. IN THE MINING INDUSTRY WORKING IN UNNATURAL POSITIONS, DOING REPETITIVE JOBS, AND LIFTING OBJECTS MAKE A MINER MORE PRONE TO _____ STRESS.
14. FATIGUE, BOREDOM, MONOTONY, AND DISCOMFORT RESULT IN THE MOST COMMON HUMAN ERROR, _____.
15. ACCIDENTS CAN BE CAUSED BY:
- A. POOR VISIBILITY
 - B. POOR ILLUMINATION
 - C. NOISE
 - D. EXERTION AND STRESS
 - E. ALL THE ABOVE
16. ACCIDENTS ARE DUE TO:
- A. EQUIPMENT FAILURES
 - B. UNAVOIDABLE NATURAL COINCIDENCES
 - C. HUMAN FAILURE
 - D. ALL THE ABOVE

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17. TRUE/FALSE - TELLING OTHER MINERS WHERE YOU ARE GOING AND WHEN YOU WILL RETURN IS AN EXCELLENT SAFETY HABIT. _____
18. ACCIDENT PREVENTION PROGRAMS REQUIRE SUPPORT FROM _____.
19. TRUE/FALSE - A GOOD SAFETY PROGRAM IS USELESS WITHOUT INDIVIDUAL SAFETY AWARENESS. _____
20. THE MAIN OBJECTIVES OF AN INDUSTRIAL HYGIENE PROGRAM ARE TO MAKE THE WORK ENVIRONMENT _____ AND _____.

-
- Answers:
- | | |
|---------------------------|---------------------|
| 1. e | 11. chemical |
| 2. cancer, 10 | 12. b |
| 3. b | 13. ergonomic |
| 4. true | 14. inattentiveness |
| 5. b | 15. e |
| 6. b | 16. d |
| 7. d | 17. true |
| 8. d | 18. all employees |
| 9. e | 19. true |
| 10. communication, source | 20. healthy, safe |

If the correct answers to the review questions were not clear, review the last part of Section D before attempting to take the course examination. If you feel it is necessary, review all sections before taking the end-of-course examination. This concludes the programmed instruction course on industrial hygiene.



QUESTIONNAIRE

INDUSTRIAL HYGIENE FOR THE MINING INDUSTRY

This questionnaire has been included to obtain feedback which will be used to improve the workbook for use by the entry-level miner. For your convenience, the questionnaire can be folded and mailed using the return address provided. No stamp necessary.

Present occupation _____ Career goal _____
Years of work experience _____ How many in mining _____
What grade did you complete in school _____
Did you attend vocational school _____ College _____
How many years _____ Major area of study _____

How many hours did it take you to complete the workbook _____
Did you like the format _____ Compared with a conventional text, is
it better _____ Worse _____ About the same _____ Was the material
too basic _____ Too difficult _____ Just right _____
Explain _____

Did you use the workbook as part of a formal training program _____
Did you need outside assistance (a text or reference material) in completing
any section in this book _____ Explain _____

Did you perform the practice exercises _____ Did you find them
useful _____ Explain _____

Were all the sections understandable _____ Explain _____

What other subjects would you recommend in this format _____

What changes would you recommend _____

General Comments: _____

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MINE GASES

MINE ILLUMINATION

NOISE CONTROL

ROOF AND RIB CONTROL

SURFACE MINING

UNDERGROUND COAL HAULAGE AND TRANSPORTATION

